SCIENCE ABSTRACTS.

Section A.—PHYSICS.

FEBRUARY, 1927.

GENERAL PHYSICS.

260. *The Relationship between the Density and Temperature of Liquids.* **A. Batschinski** and **K. Schaposchnikow.** (Zeits. f. Physik, 38. 6–7. pp. 573–574, 1926.)—A reply to the criticisms made by Predwoditelew [see Abstract 1970 (1926)]. A. A. D.

261. *Connection between the Vacuum Obtainable in the Diffusion Air Pump and the Purity of the Mercury Vapour.* **W. Molthan.** (Zeits. f. Physik, 39. 1. pp. 1–5, 1926.)—By admitting a measured quantity of air or hydrogen into the stream of mercury vapour, and determining by calculation the partial pressure of the added gas in the stream, it has been proved that the resulting vacuum is of the same order as this partial pressure, so that to obtain high vacua the mercury vapour must be free from gaseous impurities. These results agree with Gaede's theory of the diffusion pump. H. N. A.

262. *The Passage of a Current of Vapour into a Vacuum in Relation to the Action of Diffusion Air Pumps.* **W. Molthan.** (Zeits. techn. Physik, 7. 8. pp. 377–388, and 7. 9. pp. 452–461, 1926.)—Calculates how the combination of the directed velocity of the stream and the undirected molecular velocity alters the molecular free path in different directions, and thus affects the "suck" of a diffusion pump. An attempt was made to measure the velocity of mercury vapour in a diffusion pump by an electrical method, but this gave in many cases velocities greater than those which are thermodynamically possible. It is pointed out that this is due to the fact that the current by means of which the velocity is measured is mainly carried between the two platinum points employed as electrodes by electrons, and not by ions as was at first assumed. Lines of flow for a number of different cases are shown in figures in the original paper, including those in a diffusion pump and those in a vapour jet pump. The theory as developed makes it possible, in diffusion pumps with high velocity streams, to calculate the molecular free path in the diffusion slit and the velocity of the sucking action; the values obtained confirm Gaede's theory of these pumps. H. N. A.

263. *Oscillations in the Pressure Equalising Air Chambers of Reciprocating Pumps.* **F. Magyar.** (Zeits. techn. Physik, 7. 8. pp. 396–413, 1926.)—By means of harmonic analysis the conditions of resonance can be represented in a simple form. The theoretical oscillation curves are compared with the experimental results of Gramberg, good agreement being obtained. H. N. A.

264. *Production and Measurement of High Vacua.* **G. W. C. Kaye.** (Roy. Soc. Arts, J. 74. pp. 991–1007, Sept. 24; 1011–1026, Oct. 1, and pp. 1030–1047, Oct. 8, 1926. Engineering, 121. pp. 308–309, March 5, 1926.)—The subject formed the basis of three lectures in which the various methods used in the production of high vacua and the means employed to measure the degree of the vacuum were surveyed. In the technique of the process consideration was given to the importance of using wide connecting tubes, removal of absorbed and adsorbed gases in glass or metal, detection and closing of leaks, production of air-tight joints with dissimilar substances, and the use of vapour or potassium traps. The types of pumps employed (such as oil pumps, mercury pumps, molecular pumps, and mercury vapour pumps) were each explained, several examples of each being examined. Absorption methods of exhaustion were dealt with and the progressive hardening of discharge-tubes. Finally the principles of action of high vacuum gauges were examined under the following main lines: (1) those which depend on Boyle's Law; (2) those which measure molecular bombardment due to temperature difference, such as the radiometer gauge; (3) those which utilise the frictional drag of molecules on a moving surface, such as the decrement gauges and the "molecular" gauge; (4) those which turn to account the thermal conductivity of a gas, such as the hot-wire gauge; and (5) those which make use of the electrical conductivity in a gas, such as the ionisation gauge. R. S. R.

265. *Theory and Practice of Chain Weighing.* **W. Uhink.** (Zeits. Instrumentenk. 46. pp. 519–527, Oct., 1926.)—This arrangement in a general way avoids the use of small weights such as 100 milligrammes or less and the use of a rider, without any marked decrease of accuracy and with a definite hastening of the work. The author considers first a chain fixed at one end to the beam of a balance and the other end movable in a guide. Mathematical expressions are obtained for the shape of the curve assumed by the chain for different positions of its movable end. The mechanical conditions which have to be fulfilled in order that the chain may be practically useful for weighing and shall avoid errors of measurement are then investigated. R. S. R.

266. *The Functions of the Pendulum Spring.* **H. Bock.** (Zeits. Instrumentenk. 46. pp. 445–453, Sept., 1926.)—The function of the plate spring by which a clock pendulum is suspended is somewhat complicated. Similarly to the action of the chronometer spiral, it imparts to the pendulum a directive impulse supplementary to the force of gravity, whereby the period of oscillation becomes dependent on the modulus of elasticity of the steel of the spring. The main object of the paper, which is entirely mathematical, is to elucidate the nature and extent of this dependence. E. F.

267. *Use of Invar Steel for Precision Balances.* **J. J. Manley.** (Phys. Soc., Proc. 38. pp. 473–480; Disc., 480–481, Aug., 1926.)—The paper deals with certain advantages and disadvantages which accompany the use of invar steel for the beam of a precision balance. It was found that such a beam exhibits but little in the way of fatigue effects, and also that its sensitivity is nearly the same for all loads. Experiments prove that the resting point of the balance, notwithstanding the small coefficient of expansion of invar steel, may be appreciably affected by changes in temperature. This is attributed to slight relative movements amongst the several knife-edges and not to a differential lengthening of the beam itself. The instrument is affected by magnetic storms and also by the diurnal variations in the earth's magnetism. Magnetic effects may, however, be nullified by weighing according to the method of Gauss or by a method of difference. The conclusion reached is that, provided due precautions are observed, invar steel is eminently suitable for the beams of high-grade precision balances. AUTHOR.

268. *Some Sensitive Reflecting Flowmeters.* **R. M. Archer.** (Journ. Sci. Instruments, 3. pp. 410–414, Sept., 1926.)—In this paper a short description is given of several types of jet-and-vane flowmeters developed by the author for measuring small rates of gas flow. The instruments are intended to be calibrated, but over the small angular working range used the square-root law is approximately true. Alternative systems of control and methods of damping are described. AUTHOR.

269. *A Simple Integraph.* **A. A. Robb.** (Phil. Mag. 2. pp. 778–782, Oct., 1926.)—A sharp rounded edge, such as the end of a knife-blade, pressed against a plane surface of paper, can move freely in a direction tangential to itself, but not freely in a transverse direction. With suitable guidance such an edge can be made to trace out a curve on a sheet of paper. A small sharp-edged wheel turning on an axle may, with advantage, be substituted for the knife-edge Based on this principle, the author describes a simple integraph, together with the related mathematical treatment. The method is well illustrated by various applications.
H. H. Ho.

270. *Variation with Temperature of the Surface Tension of Pure Dielectric Liquids.* **G. Jung.** (Zeits. phys. Chem. 123. pp. 281–302, Sept. 15, 1926.)—The assumed orientation of the molecules of dielectric liquids in their surface layers, such that the reactive end of the chain is directed towards the interior, should also affect the surface tension and its temperature coefficient. In order to simplify the mathematical investigation of this relation the author presumes that there is no association in the surface film, though he is aware that this association is sometimes held responsible for the normal or abnormal character of liquids with respect to this temperature coefficient. In normal liquids the K of the Eötvös relation $\sigma V^{2/3}K(T_s - T)$ is said to have the value 2·12, independent of temperature, in abnormal liquids a smaller or greater value. But the abnormality need not be connected with association, and, in any case, any association in the surface film must be different from that in the interior of a liquid. Applying the Langevin-Weiss theory of the spontaneous magnetisation of α-iron below the Curie point to the spontaneous orientation of the dipole molecules on the surface of dielectrics, the author finds that the temperature variation of the internal field depends upon the degree of polarisability, and that the dipole moments can be estimated from the critical data; his calculated values for the moments are a little too large. The surface energy per unit area deduced accords only for very small dipole moments (liquefied elementary gases) with the formula of Eötvös, and is then independent of the temperature and an additive property, as in the case of normal substances, not consisting of dipole molecules (CO, CS_2, CCl_4, benzene); with abnormal liquids K approaches a universal value as the temperature rises. There is an analogy between the specific heat of the surfaces of dipole liquids and the magnetic component of the specific heat of ferromagnetic substances. H. B.

271. *Physical Properties of Glasses. Relationship to Chemical Composition and Mode of Preparation.* **W. E. S. Turner.** (Chem. Soc., J. pp. 2091–2116, Aug., 1926.)—A review of the present state of knowledge with regard to glasses, with special reference to recent work. The effect of the component oxides or elements on the physical properties is discussed. Special reference is made, amongst properties of the constitutive type, to viscosity, annealing temperature, electric conductivity, and resistance to water and chemical reagents. Amongst properties of the additive type, special consideration is given to thermal expansion, density, refractive index and dispersion. The importance of these data in the commercial preparation of glasses designed for specialised uses (*e.g.* optical glasses of specified refractive index and glasses which furnish resistance to the action of water and acids and which show a high degree of immunity towards sudden changes of temperature) is stressed. Variations in the physical properties of glasses, which are due to differences in the mode of preparation or in the heat treatment, are also considered. It is emphasised that glasses and other amorphous substances do not undergo perfectly continuous change in their properties from temperatures at which they are very fluid to those at which they are rigid, but that there is a discontinuity not essentially different from a change of state. The study of glasses may thus be expected to throw light on the nature and characteristics of the amorphous state. L. M. C.

272. *Effect of Thermal Treatment on Glass as shown by Precise Viscometry.* **V. H. Stott, D. Turner** and **H. A. Sloman.** (Roy. Soc., Proc. 112. pp. 499–521, Oct. 1, 1926.)—The viscosity of the glass was found from the thickness of the film which adhered to a thin wire of iridio-platinum which was withdrawn at a known velocity from the molten glass. The range of available velocities varied from 0·01 to 1 cm./sec., and the speed was measured by means of an electric chronograph. The tests were carried out on a glass of about the composition of N.P.L. 15, analyses being given. The observations were taken over a temperature range of 1000° C. to 1600° C., and the quantity $\kappa\eta$ is expressed in terms of the film thickness and the speed of withdrawal of the wire by means of a formula derived in an appendix; κ is a factor about 2·8, and η is the coefficient of viscosity. The experiments indicate that at temperatures below 1200° C. the glass is capable of existing in at least two states, resulting in variations of viscosity. [See also Abstract 1792 (1925).] G. E. A.

273. *Growth of Eddies in a Viscous Fluid.* **H. Levy.** (Phil. Mag. 2. pp. 844–851, Oct., 1926.)—Eddies grow by absorbing their weaker neighbours while at the same time their combined energies degrade gradually into heat. In the neighbourhood of a cylinder past which a fluid is in motion there will be periodicity in the generation of eddies so long as the speed is less than some critical value. G. A. S.

274. *Certain Irrotational Motions of Viscous Liquids.* **A. Rosenblatt.** (Comptes Rendus, 182. pp. 556–558, Oct. 4, 1926.)—Proves two theorems, (1) that in the irrotational motion of a viscuous fluid, if the force is normal to the equipotential surfaces, then these are parallel surfaces; (2) if in addition the fluid is incompressible, then the only possible families of surfaces are parallel planes, coaxial cylinders, and concentric spheres. W. G. B.

275. *Orifice Flow as affected by Viscosity and Capillarity.* **H. W. Swift.** (Phil. Mag. 2. pp. 852–875, Oct., 1926.)—The principles of dynamical similarity show that orifice flow is affected by three non-dimensional variables, $\xi = H/l$, $\eta = \nu/lv$, and $\xi = \sigma/wl^2$, H being head, l a length, ν kinematic viscosity, v velocity, σ surface tension, and w weight/unit volume. Of these the second is by far the most important, and for drowned orifices the last will not be important. The effect of surface tension can be allowed for in the case of water by a diminution $0{\cdot}008/d$ in. of the head, d being the diameter of the vena contracta. The effect of ξ has usually been ignored, but previous observers have not found it possible to make η the sole criterion, even where surface tension can be ignored. Further experiments by the author, corrected for surface tension, confirm this, but a clear physical interpretation was not obtained. The effects are, however, small within the practical range. Theory leads to a relation $C_d = C_0 \pm k\eta$ as expressing the effect of η over the useful hydraulic range, and the author's experiments agree with this, k depending upon the form of the orifice. W. G. B.

276. *Origin of the Movements of Camphor on Water and Other Allied Phenomena.* **L. A. Ramdas.** (Indian Assoc. for Cultivation of Science, Proc. 10. pp. 1–34, Aug., 1926.)—In this paper the movements of small particles of soluble organic compounds on water are related to the form of the stream-lines of flow of the material along the surface, *e.g.* when lenses of amyl alcohol float on water they are distorted and move away from the concave side, stopping, however, when the water below gets saturated and evaporation is prevented. Similar effects are observed with camphor blocks having concave edges on one side. In the case of particles of dyestuffs thrown on clean water, it has been found that micro-crystals of appreciable size are rapidly shot off from particular points on the boundary. Monomolecular films on water are made visible directly by the increased light-scattering power of the surface, and in some cases by the intense fluorescence under strong illumination. The paper is illustrated by photographs of the various phenomena described. H. H. Ho.

277. *Use of the Hot Wire Detector in determining the Path of Vortices.* **E. Tyler.** (Journ. Sci. Instruments, 3. pp. 398–400, Sept., 1926.)—Describes a method for determining the actual path of a vortex system in the wake of an obstacle such as a cylinder or an aerofoil. The apparatus consists of an electrically heated platinum wire mounted horizontally behind the obstacle in a wind channel and connected in series with the primary of a step-up transformer, the secondary of which forms part of a shunted vibration galvanometer circuit. The wind speed is adjusted until resonance occurs between the frequency of formation of the vortices and the galvanometer, set at a known frequency. The deflection of the galvanometer for resonance is assumed proportional to the amount of the periodic cooling of the hot wire. The wire is then traversed in a vertical plane and at varying distances behind the obstacle, and the corresponding deflections of the galvanometer are observed. The distance between the maxima in the curve is taken to represent the distance of separation between the two rows of the alternate vortices, since the maximum amount of periodic cooling occurs along the paths of their centres. The method is applicable to demonstrate the effect of a rotating cylinder which, according to Prandtl, results in vortices of unequal strengths being detached from the opposite sides of the cylinder. E. G.

278. *On the Technique of Making Thin Celluloid Films.* **J. Taylor.** (Journ. Sci. Instruments, 3. pp. 400–404, Sept. 1, 1926.)—The paper deals with the technique of making celluloid films of thickness of the order of the wave-length of light. In the first part the forming of celluloid films upon the surface of water is described. By this means films as large as 7 by 3 cm., of thickness of the order of 500 Å., were formed. These films, however, were not vacuum-tight. The preparation of films upon a clean mercury surface is then described. These were vacuum-tight to a difference of pressure of several cm. of mercury between the two sides. A description of an apparatus for testing the vacuum-tightness of the films and the maximum pressure that they could support without breaking is given. Further methods of making coloured films and of forming metallic mirrors upon the surface of the celluloid films by metallic evaporation are discussed. An experiment to see if the films exhibited any " structure " by X-ray analysis gave no results. AUTHOR.

279. *Structure of Thin Films. Part VIII. Expanded Films.* **N. K. Adam** and **G. Jessop.** (Roy. Soc., Proc. 112. pp. 362–375, Sept. 1, 1926.)—Using an improved apparatus, further investigation is made of the expanded state of films of fatty acids, bromo-acids, esters, methyl ketones, and other compounds possessing one chain only in the molecule, and of several compounds with more than one chain [see Abstracts 185 (1924) and 1199 (1926)]. Two types of expanded film are shown to exist. In the " liquid expanded " type a constant vapour pressure in the surface and a discontinuous transition into the " gaseous " film are exhibited. The " vapour expanded " type passes continuously into the gaseous film. The liquid expanded films show a definitely limited area at no compression, which is very close to 48 sq. Å.U. per molecule, and independent both of the nature of the head and of the length of the chain. The vapour expanded films have no limiting area, approaching the gaseous condition with rise of temperature and decrease of pressure. Near the temperature of expansion some vapour expanded films give pressure-area curves resembling those of the liquid expanded films. A helical arrangement, with vertical axes, of the long chains is suggested for the structure of the liquid expanded films, the molecules being close packed in this orientation by their mutual cohesion. Acid $KMnO_4$ in the water acts on ethylenic linkages in the middle of the chain in such a way as to make films gaseous, which would otherwise be either condensed or far removed from the gaseous state. This effect is not observed with saturated chains or with chains in which the ethylenic linkage is next to the head of the molecule. The methyl ketones form condensed films with close-packed chains, the heads packing to less than 21 sq. Å.U. Hydrolecithin, in the condensed state, exhibits hysteresis, requiring some minutes to reach its final pressure in the films. A. B. C. L.

280. *Structure of Thin Films Part IX. Dibasic Substances.* **N. K. Adam** and **G. Jessop.** (Roy. Soc., Proc. 112. pp. 376–380, Sept. 1, 1926.)—The dibasic esters $C_2H_5OOC(CH_2)_nCOOC_2H_5$, examined as described in previous papers [see preceding Abstract], are found to form monomolecular surface films of the gaseous and condensed types. The cohesional correction to the gaseous films increases with the length of the chains, the films of the esters, in which $n = 10$ and $n = 11$, being the closest approach to the perfectly gaseous state yet found with insoluble films. In the condensed films the only stable state is one with the molecules adhering to the water by one end only and packed closely and vertically. The transition from the condensed to the gaseous films is of the same nature as that from the condensed to the expanded films previously described. The condensed films expand in all cases to films of the " vapour " type. The behaviour of the acids of the series and of the mono-ethyl ester ($n = 16$) is generally similar. A. B. C. L.

281. *Geometrical Presentment of the Constants of an Elastic Material.* **R. F. Gwyther.** (Phil. Mag. 2. pp. 588–593, Sept., 1926.)—A general expression is developed for the potential function of strain per unit volume in a material when the strain is small and the material acts under strain as a conservative system. The method employed is an adaptation of the method of differential invariants and covariants of curves and surfaces as applied to vectors, stresses, strains, etc., instead of purely geometrical subjects. The potential function developed is a quadratic function of the six elements of strain and is either an invariant quadratic function or possesses permanency of form for any transformation of the coordinate axes. A. B. C. L.

282. *The Elastic Range of Friction.* **J. S. Rankin.** (Phil. Mag. 2. pp. 806–816, Oct., 1926.)—The values of the small elastic deformations of surfaces in contact, when pulled tangentially and before slipping occurs, were measured by use of a type of Whiddington's valve ultra-micrometer. For steel on cast iron, the stress-strain curve is linear, and slipping occurs, for the specimens used, when the tangential deformation reaches $0{\cdot}3 \times 10^{-6}$ cm., a value which is practically independent of the normal reaction. To examine more accurately the distribution of the friction grip, and to ensure cleanliness, glass on glass—optical polish—was used, and the layer of air between observed by means of interference fringes. A wedge-shaped layer of air was found to be trapped between the plates, of mean thickness ten or more times the mean free path in the air (10^{-5} cm.), so that the solid surfaces are well without the range of direct action upon one another. A considerable increase of load could be applied without altering the number of bands, and the top plate slipped all over the bottom one without altering the fringe system. It was found that the coefficient of friction increased from 0·13 when the thickness of the layer was greater

than 0·0002 cm., to above 0·33 when the thickness was 0·000015 cm. Brass and wrought iron plates of good optical polish were also examined.
W. G. B.

283. *Effect of Gases, Vapours and Liquids on the Limiting Friction between Solid Surfaces.* **J. M. Macaulay.** (Engineering, 122. pp. 619–621, Nov. 19, and pp. 654–655, Nov. 26, 1926.)—This paper investigates how far the friction between solid surfaces is altered by the nature of the atmosphere in which the surfaces are placed, and an apparatus is fully described which enables plates of glass, brass and steel to be laid together in different gases, *viz.* air, hydrogen and carbon dioxide, saturated and dry. In every case the addition of water vapour to a dry atmosphere is shown to produce a notable increase in the coefficient of the limiting friction, which was substantially greater for hydrogen and carbon dioxide than for air. Flooding glass surfaces with water produced an even greater increase in friction than water vapour. No appreciable difference is shown in the coefficients obtained with glass in dry atmospheres of air, hydrogen and carbon dioxide. A theoretical explanation is tentatively advanced to account for the effects due to water and its vapour, and illustrative experiments on ethyl ether, acetic anhydride and bromine described. The theory is then applied successfully to the experiments of Hardy and Bircumshaw [see Abstract 2414 (1925)], pressure and temperature effects being also taken into consideration.
H. H. Ho.

284. *Flexure of Thick Circular Plates.* **C. A. Clemmow.** (Roy. Soc., Proc. 112. pp. 559–598, Oct. 1, 1926.)—This investigation arose out of a suggestion that the deflection of a circular steel plate, firmly held at the edge, might be used as a measure of high explosive pressures. The plate would form the base of a cylindrical closed vessel of the usual type, and the measurement made would be that of the normal central deflection of its external flat surface. Three types of solution of the problem have been considered: (1) that in finite terms; (2) that in infinite series involving hyperbolic functions of z and Bessel functions of r; (3) that afforded by a combination of (1) and (2); r and z are cylindrical coordinates and $2h$ is the thickness. No one of the above has been found to solve the problem in its complete generality: (1) leads to the usual results for thin plates of neglected thickness; (2) is of restricted application, as boundary conditions at the edge referring to one displacement only can be satisfied; (3) in various forms permits of the discussion of a variety of problems, the method being to satisfy the stress boundary conditions over $z = \pm h$, and then to consider different boundary conditions at $r = a$. Methods have also been indicated for the discussion of the problem for the case of non-uniform loading, particularly when the load is concentrated entirely at the centre. The theoretical results for thick plates are expressed in the form of infinite series, which have been reduced to simple terms, so that concise approximate expressions for stresses and displacements are obtained which are valid in most cases, even for comparatively thick plates. The paper is mathematical throughout, and the distribution of stress throughout the plate in the cases considered is given by tables.
H. H. Ho.

285. *Permanent Deformations produced by Contact of Solids.* **K. Banerji.** (Indian Assoc. for Cultivation of Science, Proc. 10. pp. 59–74, Aug., 1926.)—This paper records the experimental study of percussion figures produced by steel balls of different diameters falling from different heights on glass slabs and also by slow pressures on balls in contact with them. The crack is found to spread into the glass as a clearly defined and very regular surface of revolution, while on the surface it appears as an annular area inside which the glass is broken. The external diameter of the annulus is nearly equal to the diameter of the circle of contact, calculated on Hertz's theory. Examinations of the permanent deformations produced by hard steel balls impacting on a soft cast-steel block show that the central part is depressed while the sides are raised up. It is concluded that the density of steel is temporarily increased by impact and decreased by slow compression. Raman's work [see Abstract 13 (1920)] should be consulted. The paper concludes with a criticism of the methods of hardness determinations. H. H. Ho.

286. *Determination of the Atomic Weight of Silver by the Direct Ratio of Silver to Oxygen in Silver Oxide.* **H. L. Riley** and **H. B. Baker.** (Chem. Soc., J. pp. 2510–2527, Oct., 1926.)—Although it is found possible to dry silver oxide over pure phosphorus pentoxide at the ordinary temperature or in a vacuum at 100° C. without the loss of an appreciable amount of oxygen, it seems that a very small quantity of oxygen must be lost, as the dried oxide always gives a pink chloride on treatment with hydrochloric acid. The pink chloride is not, as C. Lea supposed, the photochloride, as it is obtained from the oxide prepared and dried in absolute darkness. When scrupulous care is taken to exclude organic matter or carbon dioxide from the oxide, this can be prepared so pure that it gives a white chloride. From the ratio between the weights of silver oxide and the silver it yields the value 107·864 ± 0·0013 is found for the atomic weight of silver (O = 16). T. H. P.

287. *Crystal Structure of Meteoric Iron.* **J. Young.** (Roy. Soc., Proc. 112. pp. 630–641, Oct. 1, 1926.)—From an X-ray study of the large-scale structure of meteoric iron it was hoped to get results applicable to artificial alloys which usually have too fine grained a structure for application of the methods. Attention is given to (1) the X-ray reflections from the octahedral planes of meteoric iron, (2) determination of the orientation of the kamacite crystal with respect to the Widmanstätten structure, and (3) the origin of the Widmanstätten structure. It is concluded that kamacite is a body-centred cubic crystal and that kamacite and tænite grow so that a (110) plane of kamacite is parallel to a (111) plane of tænite. W. H. Ge.

288. *Structure of γ-Brass.* **A. Bradley** and **J. Thewlis.** (Roy. Soc., Proc. 112. pp. 678–692, Oct. 1, 1926.)—(1) The structure of γ-brass has been deduced from the data of Westgren and Phragmén, who had already shown that it was cubic, the lattice dimensions of the unit cell being about 8·9 Å. (2) γ-brass has the formula Cu_5Zn_8, each unit cell containing 20 copper atoms and 32 zinc atoms. (3) The space-group is T_d^3. There are four sets of equivalent positions containing, respectively, 8, 8, 12 and 24 atoms. (4) The arrangement of atoms is almost body-centred, but in each unit cell there are two atoms less than would be required for such a simple arrangement. (5) The different sets of atoms are displaced by definite amounts from the body-centred positions. These displacements have been measured. (6) The interatomic distances are about 2·6 Å., which is about the same value as in the elements Cu and Zn. (7) γ-Ag-Zn and γ-Au-Zn are similarly constituted, the formulæ being Ag_5Zn_8 and Au_5Zn_8 respectively. G. W. DE T.

289. *Remarks on a Paper by K. F. Herzfeld and A. Hettich on the Symmetry of Sylvine and the Nature of Etch Figures.* **J. J. P. Valeton.** (Zeits. f. Physik, 39. 1. pp. 69–74, 1926.)—Contests the view of the above authors that their experiments prove that potassium chloride crystals are holohedric [see Abstract 2527 (1926)]. They appear to hold that a crystal which only under certain conditions gives symmetrically oriented etch figures is certainly holohedric, and consider that the fact that it gives asymmetrical etch figures under certain other conditions, *e.g.* in the presence of impurities, points to the asymmetrical nature of the impurities, an explanation which appears to be unsatisfactory and quite unnecessary, since the symmetrical etch figures in no way contradict the plagiohedric-hemihedric nature of sylvine. H. N. A.

290. *Arrangement of the Atoms in the Tetragonal Crystals of Potassium Metaperiodate,* $K_2I_2O_8$. **E. Hylleraas.** (Zeits. f. Physik, 39. 4. pp. 308–321, 1926.)—The elementary cell contains eight K atoms, eight I atoms and thirty-two O atoms. The lattice contains two face-centred potassium lattices and two face-centred iodine lattices, each forming a diamond lattice, and in addition eight face-centred oxygen lattices. To obtain correct values for the intensities of the reflected lines it is necessary to assume a tetragonal bipyrimidal structure. The lattice belongs to the space group C_{4h}^{6}, and the oxygen atoms form the most general arrangement of points consistent with this group, having three degrees of freedom; groups of four of them surround each I atom at the corners of a tetrahedron, and the author assumes that each I atom has a charge $+ 7e$ and each O atom a charge $- 2e$, the whole group forming an ion with charge $- e$. The ionic radii deduced from the atomic distances point to the fact that the atoms have all attained the configuration of the rare gases by giving or taking up electrons. H. N. A.

291. *The Brownian Movement for the Same Substance at Different Pressures and in Different Gases.* **S. Kwartin.** (Zeits. f. Physik, 38. 8. pp. 600–608, 1926.)—Landman [see Abstract 2908 (1924)] has previously examined the Brownian movement at different pressures, and the present author supplements this work and extends it for different gases, *e.g.* nitrogen, hydrogen and carbon dioxide. Experimental details are included. It is found that the animation of the Brownian movement increases in a less dense medium (hydrogen) as it does under reduced pressures. The values (radius, mass, charge) calculated from the Einstein theory for the different pressures and gases lie with but a few exceptions outside the Schrödinger limits of error. In particular the Loschmidt numbers vary from $2·6 \times 10^{23}$ to $15·2 \times 10^{23}$. This lack of agreement is tentatively explained from the standpoint that the results of measurement with the Einstein formula, $B = \overline{N\lambda^2}/2RT$ (according to which the motion should be directly proportional to the average square of the displacement per sec.), are not in complete agreement, and may possibly call for a modification of the formula. H. H. H.

292. *Anomalies of the Brownian Movement in Gases.* **B. Bäcker.** (Zeits. f. Physik, 38. 8. pp. 609–620, 1926.)—Einstein and Smoluchowski [see Abstract 743 (1906)] independently of each other proposed a theory for the Brownian movement, which later Ehrenhaft extended to gases. The present paper deals with existing anomalies. Under the assumption that fall and rise movements are identical, the average square of the displacement, whether calculated from the rates of rise or fall, must be the same. By the application of statistics, however, from 3740 separate observations with oil and 7346 with selenium, it is shown that $\overline{\lambda_s^2} > \overline{\lambda_f^2} > \overline{\lambda_H^2}$, where s, f and H denote rise, fall and horizontal movements respectively. Since the oil measurements were also carried out under reduced pressures, the deviations could be ascribed to currents which arise during the pump operations. In consequence the author has modified the Weiss formula to eliminate eventual currents, but even then cannot confirm the Einstein relationship by its means. The deviations are, therefore, held to be due to other causes. Since from many measurements the horizontal square-displacement is found to be smaller than the vertical, the inequality $\overline{\lambda_s^2} > \overline{\lambda_f^2} > \overline{\lambda_H^2}$ may be itself a responsible cause. It is shown that the assumption of a persistence of the direction of motion in consequence of a force effect will explain the anomalies. H. H. Ho.

293. *Polarisabilities of Atomic Cores.* **Bertha Swirles.** (Cambridge Phil. Soc., Proc. 23. pp. 403–411, Oct., 1926.)—Born and Heisenburg and Schrödinger have derived expressions for the polarisability of the core, the former from direct considerations and the latter from an application of the correspondence principle. These expressions are supplementary, and have been applied in detail to some elements with one series electron, AlI, SiII, NaI, MgII, AlIII. A. Wh.

294. *Theory of Quantum Mechanics.* **P. A. M. Dirac.** (Roy. Soc., Proc. 112. pp. 661–677, Oct. 1, 1926.)—The present theory is shown to account for the absorption and stimulated emission of radiation, and also shows that the elements of the matrices representing the total polarisation determine the transition probabilities. One cannot take spontaneous emission into account without a more elaborate theory involving the positions of the various atoms and the interference of their individual emissions, as the effects will depend upon whether the atoms are distributed at random, or arranged in a crystal lattice, or all confined in a volume small compared with a wave-length. The last alternative mentioned, which is of no practical interest, appears to be the simplest theoretically. It should be observed that we get the simple Einstein results only because we have averaged over all initial phases of the atoms.

G. W. DE T.

295. *Quantum Theory of the Problem of Two Bodies.* **J. R. Oppenheimer.** (Cambridge Phil. Soc., Proc. 23. pp. 422–431, Oct., 1926.)—An attempt is made to solve more generally than has previously been accomplished the quantum mechanical problem of an ion and an electron. The methods of Schrödinger, using the characteristic functions of the wave equation $\nabla^2 u + \frac{8\pi^2\mu}{h^2}\left(E + \frac{\epsilon^2}{r}\right)u = 0$, are employed. The line intensities of the hydrogen spectrum are evaluated and a discussion is given of a method for obtaining the radiation from hyperbolic orbits. The problem of the photoelectric and the inverse photoelectric effects is attacked and a formula obtained for the continuous absorption spectrum. The probabilities of transition, deflection and capture in a collision of an electron with an ion are computed. W. S. S.

296. *Quantum Algebra.* **P. A. M. Dirac.** (Cambridge Phil. Soc., Proc. 23. pp. 412–418, Oct., 1926.)—In a previous paper [Abstract 1245 (1926)] the idea of *q*-numbers was discussed. The algebra of *q*-numbers has been hampered by the lack of a satisfactory definition of a function of a *q*-number variable. In this mathematical paper a definition is derived. A. Wh.

297. *The Problem of Several Bodies and Resonance in Quantum Mechanics.* **W. Heisenberg.** (Zeits. f. Physik, 38. 6–7. pp. 411–426, 1926.)—In this investigation the author attempts to find a basis for the quantum mechanical treatment of the problem of several bodies. For this purpose characteristic resonance phenomena are investigated, and a connection established with the Einstein-Bose results and the Pauli prohibition of equivalent orbits. The author is satisfied that the Schrödinger process [see Abstract 1512 (1926)], which proceeds from the de Broglie wave theory of matter, will be of great assistance in quantum mechanics, not only for mathematical operations, but also for the presentation of useful analogies for the study of processes in infinitesimal spaces. H. H. Ho.

298. *Remarks on Heisenberg's Quantum Mechanics.* **N. v. Raschevsky.** (Zeits. f. Physik, 39. 2–3. pp. 153–158, 1926.)—The fundamental tendency of the original form of the Heisenberg method was to make use only of magnitudes which could in principle be observed in describing the behaviour of atoms, but Born and Wiener have to a certain extent departed from this, and Dirac to a still greater degree. Schrödinger has shown that his theory leads to the same final results as that of Heisenberg. The author examines Heisenberg's original proposal, and points out that according to it only such magnitudes as the magnetic or electric moment of the atom, the intensities of the spectral lines, and, above all, their wave-length *in vacuo* are to be employed; even frequencies should not be introduced, since they can only be arrived at from the equation $\nu = c\lambda$, and c is not in principle a measurable magnitude. There are certain purely algebraical relations between the above magnitudes, and these relations constitute an atomic theory. Time does not, strictly speaking, enter into the theory, and differentiation with respect to time is only introduced to obtain a formal similarity with the classical equations of motion. As far as our knowledge of atoms is concerned, both space and time can only be considered in a statistical sense, and inside one, and even with regard to a small number of atoms, they cannot be given any physical meaning. The above statements, however, are not to be read as denying the possibility of some such interpretation of the nature of atomic phenomena as that of Schrödinger. H. N. A.

299. *Reciprocal Action between Radiation and Quadrupole Atoms.* **I. I. Placinteanu.** (Zeits. f. Physik, 39. 4. pp. 276–298, 1926.)—The method given by Born and Jordan [Abstract 2492 (1925)] for investigating the reciprocal action between radiation and atoms in the case of a dipole model is here applied to quadrupole atoms. A. W.

300. *The Monatomic Molecules of the Rare Gases.* **F. J. v. Wiśniewski.** (Zeits. f. Physik, 39. 4. pp. 299–307, 1926.)—It is shown that it is possible to explain much of the experimental material on the assumption that the atoms of the rare gases consist of a monovalent ion and an electron revolving round it; the former, the atomic trunk, is regarded as having the dimensions of a point, and the structure is approximately similar to that of the hydrogen atom. The radius of the electron orbit, calculated from the dielectric constant of the gas, corresponds quite well with the radius of the atom determined from the viscosity except in the case of helium. The energy levels of the outer electrons in the most probable state are calculated, and it is shown that they correspond with those observed for argon, krypton and xenon. The observed and calculated values of the diamagnetic susceptibility are not very different in the cases of argon and neon; no observations seem to be available for krypton and xenon. It is also shown that the structural model which has been developed for the diatomic molecules HCl, HBr, HI, CO and N_2 and the triatomic HCN also explains the properties of O_2, CO_2 and H_2S. H. N. A.

301. *Number of Dispersion Electrons deduced from Undulation Mechanics.* **F. London.** (Zeits. f. Physik, 39. 4. pp. 322–326, 1926.)—Schrödinger has recently published a quantum theory for dispersion which gives a very definite concrete extension of the scheme of formulæ put forward by Kramers and by Kramers and Heisenberg [see Abstract 1632 (1925)]. Kuhn and Thomas, using the correspondence principle, have determined some of the magnitudes of quantum mechanics in Kramers' formulæ and arrive at a summation law which Thomas and Reiche make use of to obtain important conclusions with regard to the intensities of spectral lines in simple cases. The author deduces the Thomas-Kuhn summation law from the point of view of Schrödinger's undulatory mechanics; he finds that it indicates a connection with the number of dispersion electrons, and proves directly the correctness of the problematical explanation of the density of the electrical charge given by Schrödinger. H. N. A.

302. *Effective Area of Hydrogen and Nitrogen Molecules for Slow Electrons.* **E. Brüche.** (Ann. d. Physik, 81. 6. pp. 537–571, Oct. 26, 1926.)—A full description is given of a simple apparatus for measuring the effective area of gas molecules with respect to slow electrons. The possible sources of error are discussed in detail. Measurements of the effective area of argon for different electron velocities are found to agree with the values given by Ramsauer. The experiments with hydrogen and nitrogen show that in both cases the effective area increases as the electron velocity decreases, attaining a maximum for a velocity corresponding to 1·2 (hydrogen) or 1·5 (nitrogen) $\sqrt{\text{volts}}$. With nitrogen a second small maximum occurs at about 4·2 $\sqrt{\text{volts}}$. These results differ from those found by Mayer using similar apparatus. His results indicate that the effective area is practically independent of velocity over a range including the maxima given by the present experiments. The qualitative method for tracing the course of the effective area electron velocity curve, due to Åkesson, is used to obtain confirmation of the quantitative results quoted above. W. S. S.

303. *Orbits and Light Radiation of Hydrogen Electrons.* **T. Engset.** (Ann. d. Physik, 80. 8. pp. 823–828, Aug. 21, and pp. 572–576, Oct. 26, 1926.)—In this note a modified treatment on the lines of the method used in Schrödinger's first communication [see Abstract 1512 (1926)] is given of the motion of an electron about a positive nucleus. The author is led to consider a certain function of position which varies periodically along the orbit. The number of complete periods of this function passed through in unit time by the orbital electron is found to equal $-E/h$, where E is the total energy of the system. This is precisely the frequency of the radiation corresponding to an electron jump from infinity to the stable orbit under consideration. Using this relation, a physical picture of the radiation process is outlined. In the second note this picture is further developed, the basic assumption being that the radiation is due to oscillations of the charge of the orbital electron. W. S. S.

304. *Certain Characteristic Oscillations with Continuous Spectrum.* **A. Wintner.** (Ann. d. Physik, 81. 6. pp. 577–586, Oct. 26, 1926.)—A number of mathematical notes bearing on the solution of the systems of differential equations encountered in the theory of infinite lattices.

W. S. S.

305. *Undulation Mechanics of the Molecular Ion of Hydrogen.* **W. Alexandrow.** (Ann. d. Physik, 81. 6. pp. 603–614, Oct. 26, 1926.)—The ionisation potential of the hydrogen molecule, as computed on the basis of the "classical" quantum theory, amounts to 23·7 volts, in complete disagreement with the value 16·4 volts found experimentally by H. D. Smyth. The problem is here attacked by the methods of the Schrödinger undulatory mechanics. The form of the Schrödinger wave equation employed is based on the model of the hydrogen molecule used by Born in his "Atommechanik." The "Eigenwerte" or characteristic values of this equation correspond to the energy levels of the system. The ionisation potential obtained theoretically is identical with Smyth's experimental result. The relations of the multiple line spectrum of the H_2^+ ion to the Balmer lines are also elucidated. W. S. S.

306. *Four-Dimensional Formulation of Undulatory Mechanics.* **J. Kudar.** (Ann. d. Physik, 81. 6. pp. 632–636, Oct. 26, 1926.)—In this mathematical paper the wave equation for relativity mechanics is derived in the general case of four-dimensional potential and with reference to the earlier standpoint of Schrödinger [see Abstract 1512 (1926)] and the three-dimensional treatment of Fock [see Abstracts 1365 (1925), 2017 and 2536 (1926)]. H. H. Ho.

307. *Static and Isotropic Gravitational Fields.* **G. Temple.** (Phys. Soc., Proc. 38. pp. 337–349; Disc., 349, Aug. 1, 1926.)—The object of this paper is to give a brief account of the principles of Einstein's general theory of relativity as applied to those problems in which they have received their most striking confirmation. To this end the investigations have been limited to the consideration of dynamical manifolds which are static and isotropic in character. It has then proved possible to abandon the notation and theory of the absolute differential calculus and to substitute in its place some classical theorems of Lord Kelvin and M. J. Liouville. Although the scope of these inquiries is not extensive, within the limits of the investigations the method is explained of the construction and solution of Einstein's field equations, and the applications are given of these results to the problems of planetary motion and of the deviation of light rays in the solar gravitational field. At the same time it is endeavoured to make explicit the various assumptions involved in this theory. AUTHOR.

308. *Application of Quantification deduced from Einstein's Theory of Gravitation.* **T. de Donder.** (Comptes Rendus, 183. pp. 594–595, Oct. 11, 1926.)—The method of quantification of molecular systems by means of the general theory of relativity, developed by the author in a previous note, is applied to the quantification of an electron moving in an arbitrary gravitational and electromagnetic field. J. S. G. T.

309. *The Atomicity of Electricity as a Quantum Theory Law.* **O. Klein.** (Nature, 118. p. 516, Oct. 9, 1926.)—A development of the five-dimensional theory of the interconnection of the electromagnetic and gravitational fields, due to Kaluza and Klein [see Abstract 2541 (1926)], leads to the suggestion that the atomicity of electricity may be interpreted as a quantum theory law, and that the origin of Planck's quantum may be sought in the periodicity of the fifth dimension involved in the theory. J. S. G. T.

310. *Invariant Form of the Wave and Motion Equations for a Charged Mass Point.* **V. Fock.** (Zeits. f. Physik, 39. 2–3. pp. 226–232, 1926.)—Mandel, in an as yet unpublished paper, has found the conception of five-dimensional space to enable the consideration of gravitation and the electromagnetic field from a single standpoint. The present author now describes the Schrödinger wave equation as an invariant Laplace equation and the equations of motion as those of a geodetic line in five-dimensional space. The surplus fifth coordinate parameter is found to stand in close relationship to the linear differential form of the electromagnetic potential. Klein's paper [see Abstract 2541 (1926)], which appeared while the present one was in the press, should be consulted, as it gives an alternative mode of treatment. H. H. Ho.

311. *Equilibrium of Matter and Radiation in Einstein's Finite Universe.* **W. Lenz.** (Phys. Zeits. 27. pp. 642–645, Oct. 15, 1926.)—The application of ideas due to Stern to the consideration of equilibrium between matter and radiation in Einstein's finite universe leads to the conclusion that in such a universe radiant energy and material energy must be equal to one another. The temperature T of space in such a universe of radius R is given by $T^2 \sim 10^{31}/R$. J. S. G. T.

312. *The Form of the Space-Time Surface of a Gravitational Field due to a Mass concentrated at a Point.* **E. Loedel.** (Phys. Zeits. 27. pp. 645–648, Oct. 15, 1926.)—The significance of gravitation in Einstein's general theory of relativity is illustrated by reduction of the four-dimensional form of the line element to a three-dimensional Euclidean form in the special case in which $\theta = \text{const.}$ and $\phi = \text{const.}$ J. S. G. T.

313. *The Michelson Experiment carried out in a Balloon. Failure of the Ether and Ether Drift Hypothesis.* **G. Guadet.** (Rev. d'Optique, 5. pp. 363–378, Sept., 1926.)—Recent results obtained in a repetition of the Michelson experiment carried out in a balloon by Piccard [see Abstract 60 (1927)] are contrary to those obtained by Miller at Mount Wilson, and the author suggests that the hypothesis of an ether drift, and even of the existence of an ether, should now be definitely abandoned.

J. S. G. T.

METEOROLOGY AND GEO-PHYSICS.

314. *Variance of Upper Wind and Accumulation of Mass.* **L. F. Richardson, D. Proctor** and **R. C. Smith.** (Roy. Meteorolog. Soc., Mem. 1. pp. 59–78, 1926.)—It is shown that the variance (σ^2) of the vertical component of the upper wind from zero is about $\frac{1}{4}$ m.^{2} s.$^{-2}$, and that the variance from its mean of the error in the measurement of the horizontal wind by the single theodolite method is about 1 to 2 m.^{2} s.$^{-2}$. Observations for a single station at different times show that the variance of the horizontal W-E component increases from nothing at the zero-time interval to a peak at 6 hours, cuts the asymptote at 1 or 2 days, attains a maximum at 11 days, and cuts the asymptote again at 19 days. For paired stations between 10 km. and 100 km. apart the variance of the difference of the component velocity is k times the distance apart of the stations, where k has the values $5{\cdot}4 \times 10^{-3}$ cm. s.$^{-2}$ and $3{\cdot}6 \times 10^{-3}$ cm. s.$^{-2}$ for the components respectively parallel and at right angles to the resultant at one station. For a square of side l on the map, 10 km. $< l <$ 100 km., with the wind accurately known along three sides, but only at the centre of the fourth side, the uncertainty in the fractional rate of the change of the area of the air filling the square has a standard deviation $\sqrt{\dfrac{k}{12 \cdot l}}$ per sec. A. W. L.

315. *Foundation of a New Triangulation of Geographical Positions.* **R. Jouaust.** (Onde Élec. 5. pp. 429–433, Sept., 1926.)—Details are given of a test to be undertaken by fifty observatories or astronomical stations, scattered over the earth, according to a method suggested by Ferrié [see Abstract 1038 (1922)]. Messages from eight radio telegraphic stations will be used and simultaneous astronomical observations made. It is expected that by more exact knowledge of geographical positions it will be possible to test again in a short time and discover if changes have occurred in terrestrial positions. Wegener's theory of continental drift can thus be tested. R. S. R.

316. *Nile Flood and World Weather.* **E. W. Bliss.** (Roy. Meteorolog. Soc., Mem. 1. No. 5. pp. 79–85, 1926.)—The Nile flood from 1869 to 1925 is expressed as annual departures from the mean of the Aswan discharges from July to October. Correlation coefficients, with quarterly values of meteorological conditions at the centres of world weather adopted by G. Walker, are obtained for each of the five quarters centring at the flood. The highest correlations for pressure, temperature and rainfall amount to − 0·64 with contemporary pressure at Cairo; − 0·72 with Samoa temperature two quarters after the Nile; + 0·54 with contemporary rainfall in N.W. India. The Nile behaves as a member of the first group of the southern oscillation, and is inversely related to equatorial temperatures and to the North Atlantic circulation in the following winter. The correlation is higher with subsequent than with preceding weather. A formula for predicting the Nile flood, from Dutch Harbour temperature and Port Darwin pressure in the preceding quarter and Samoa temperature two quarters previously, gives a joint correlation of + 0·72. A. W. L.

317. *Rôle of Secondary Diffusion in the Polarisation of the Sky.* **J. J. Tichanowsky.** (Meteorolog. Zeits. 43. pp. 361–366, Oct., 1926.)—Schirmann and Milch denied the influence of secondary diffusion on the polarisation of light from the sky. The author considers that the explanation of the deviation of the observed pictures of this phenomenon from the original theory of Rayleigh simply by the presence of large particles in the atmosphere has not sufficient basis for acceptance. From a statement of Ahlgrimm's theory for this polarised light, in which account is taken of secondary diffusion and which explains quantitatively many sky phenomena of polarisation, it is shown that the theoretical values agree well with measurements of the maximum and zenithal polarisation for different solar altitudes if one bears in mind the amount of dust and water vapour present. Results obtained at Tashkent and Ai-Petri were used [Abstract 69 (1927)]. Extending Ahlgrimm's theory to the case of the anisotropic molecule of air, the zenithal polarisation for a sun's altitude of 0° becomes 833, which value agrees well with direct measurements, although somewhat smaller than the value found by the author by extrapolation for the value of the polarisation in an absolutely pure atmosphere, *i.e.* 877 at Ai-Petri and 870 at Simferopol. This is partly due to errors in measurement of the dust and water-vapour content in the atmosphere. Further, as indirect proofs of the important part which secondary diffusion plays, the author suggests the approximate constancy of the amount of the polarisation with the increase of the height above the sea-level of the place of observation and the character of the dispersion and the polychroism for the pure atmosphere. R. S. R.

318. *Development of Aerology.* **H. Hergesell.** (Meteorolog. Zeits. 61. pp. 322–329, Sept., 1926.)—The author gives a summary of the part played, mainly by German meteorologists, in the history of the subject, dealing with kite, free and captive balloon ascents in Europe over the North and South Atlantic Oceans and in Central Africa and the part they played in establishing the structure of the atmosphere. For present needs in Germany, for air traffic and scientific study he considers the number of pilot balloon stations is sufficient. Additional kite balloon stations, one each in East and West Germany are required, while more than the one aerodrome (Staaken) now available is necessary from which aircraft may make ascents into the higher levels of the atmosphere for purposes of scientific investigation. R. S. R.

319. *Criticism of Correlation Factors.* **A. Schmidt.** (Meteorolog. Zeits. 61. pp. 329–334, Sept., 1926.)—The author deals with several isolated questions, which are not usually considered in the literature of the subject, to make a critical comparison of the method of correlation factors with the method of least squares. The treatment is largely mathematical. It is concluded that upon the whole the method of correlation factors is limited to the region of the preliminary investigation, and that even here better results are often obtained by other simple means. R. S. R.

320. *Compressional Waves in Two Superposed Layers.* **H. Jeffreys.** (Cambridge Phil. Soc., Proc. 23. pp. 472–481, Oct., 1926.)—The assumption that the compressional waves of earthquakes follow the ordinary laws of refraction, the energy within any pencil of rays remaining permanently within that pencil, has been found to lead to too small amplitudes for the indirect waves from near earthquakes. In this paper a system consisting of two superposed compressible, but non-rigid, media is considered; the lower is supposed to transmit compressional waves with the greater velocity. It is found that an explosion within the upper medium produces a disturbance at the upper surface involving the direct wave and all the reflected waves that might be expected, but in addition a wave is found that appears to have travelled along the interface with the velocity of sound in the lower medium. This indirect wave would have zero amplitude on the simple laws of refraction with plane boundaries. The variation of its amplitude with distance from the focus is in reasonable accordance with seismological observation, and its time of arrival agrees with that inferred from the laws of refraction for boundaries with slight curvature. But if the direct wave begins with a finite velocity, the indirect one will begin with a finite acceleration; in seismological language an iP_g will be associated with an eP_n. The indirect wave will also take longer than the direct one to give its maximum displacement. G. W. DE T.

ASTRO-PHYSICS.

321. *Solar Hydrodynamics.* **V. Bjerknes.** (Mt. Wilson Observat. Contrib. No. 312. Astrophys. J. 64. pp. 93–121, Sept., 1926.)—Hydrodynamical discussion of internal solar motions, especially vortex motions for explaining sunspots. It is shown that the low temperatures of sunspots may be explained if the vortices connected with them decrease in intensity from the surface downwards. The excess of centrifugal force in the upper part of the vortex then gives rise to a centrifugal pumping effect, by means of which the gases in the central region are lifted from below and adiabatically cooled. A simple view of the numerous collective properties of sunspots is obtained by making the following suppositions: Sunspot phenomena originate in two sub-photospheric zonal vortices, one for each cycle, which have opposite rotations. These vortices occasionally rise to the surface and penetrate the sun's atmosphere, and then return again below the photosphere. Wherever a sinuous vortex rises and cuts the photosphere a sunspot of the corresponding cycle makes its appearance or may be discovered. The direction of rotation is supposed to determine the sign of the magnetic field. In virtue of the internal circulation of the sun, which may also explain the phenomenon of the equatorial acceleration, the two vortices revolve round each other, the period of revolution being the complete sunspot period of twenty-two years. AUTHOR.

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322. *A Simple Machine for Comparing Two Celestial Photographs.* **F. Schlesinger.** (Astron. J. 37. pp. 45–47, Sept. 30, 1926.)—The two photographs are attached to a rigid frame, one above the other and several inches apart. Between them projects a micrometer microscope, into the axis of which corresponding regions on the two photographs are simultaneously reflected by a suitable optical device. The photographs can now be moved together across the field of the microscope in two coordinate directions, so that all their parts come successively into view. In addition to its low cost compared with Pulfrich's stereocomparator, it is claimed that this machine has advantages of compactness, portability and stability. Its construction is shown in three figures which should be examined in the original paper. E. F.

323. *Observations with the Spectroheliоscope.* **G. E. Hale.** (Nature, 118. pp. 420–421, Sept. 18, 1926.)—The spectrohelioscope, described in a former article [see Abstract 2294 (1926)], has now been provided with new oscillating slits and driving mechanism, and an improved parallel-plate line shifter and micrometer for setting various parts of the Hα line on the second slit with divided arc indicating the exact wave-length employed. This makes it easy to determine the direction in the line of sight and to measure the velocities of hydrogen jets and prominences as seen in projection against the disc, as well as in cross-section at the limb. It has been observed in three cases that slender dark flocculi, when the slit was moved to the red side of Hα, appeared as points at their extremities, which were touching the outer boundary line of a sunspot penumbra; and this is interpreted as implying a rapid descent of the hydrogen in the vortex above the spot. In the same way eruptive jets which rise near spots and descend at some distance after following a long-arched trajectory appear at their source as bright flocculi, seen on the violet side of Hα, and become dark absorbing streams at a higher level, finally descending at a velocity which produces a marked displacement to the red beyond the normal boundary of the Hα line. Further, some eruptive jets near the centre of the sun give a displacement of the bright Hα line to the violet; but others are receding or stationary in the line of sight, and it is probable that these are often due to the descent of comparatively cool hydrogen. Terrestrial magnetic storms and auroræ will probably be found to result from the presence of the bright ascending jets, which emit charged particles at velocities sufficient to carry them to Earth. The author hopes that spectrohelioscopes will be built and used at stations well distributed in longitude, in order to determine the relationship between these solar and terrestrial phenomena. He is now building inexpensive and powerful instruments of this kind, after many preliminary tests. M. A. E.

324. *Notes on Proper Motions. Part I.* **W. J. Luyten.** (Harvard Coll. Obs. Circ. No. 293. [6 pp.], 1926.)—In view of the urgent demand for proper motions for various classes of celestial objects, it seemed desirable to investigate the accuracy with which proper motions can be determined photographically from material existing at Harvard. The results indicate the possibility of determining them with a mean error of 0″·038 from one pair of plates taken with the 8-in. Draper telescope or with the 8-in. Bache telescope, at an interval of twenty-five years. Accordingly, the proper motions of a few special stars, and of twenty-five long-period variables, have been determined by this method, and are here tabulated. M. A. E.

325. *Velocity Curves of* 12 *Lacertæ and Radial Velocities of* 48 *Stars.* **W. H. Christie.** (Dominion Astrophys. Obs. Victoria, Publ. 3. 9. pp. 209–223, 1926.)—One hundred and fifty-two spectra of the short period, variable-velocity star 12 Lacertæ (α 22h. 37·0m., δ + 39° 43′) have been measured. These include two series taken by R. K. Young in 1922 and 1923, and three by the writer in 1924. The last of the series, consisting of 76 spectra taken in succession and covering two complete cycles, indicates that the change in amplitude, previously noted by Young, is rapid. The velocity derived from the calcium lines is in close agreement with the solar motion, being − 14·1 km./sec., whereas the solar component is − 11·0 km./sec. In addition, the radial velocities of 48 stars, selected from a general programme of H.R. stars, have been determined, in the majority of cases four or more spectra of each star being obtained. Of these nine stars were found to be binaries. AUTHOR.

326. *Four Double-Lined F-Type Spectroscopic Binaries.* **W. E. Harper.** (Dominion Astrophys. Obs. Victoria, Publ. 3. 10. pp. 225–245, 1926.)—The four double stars here discussed all show the spectra of both components. In one the lines have about equal strength, and as the semi-amplitudes of velocity variation are equal it follows that the masses are equal. In another there is a slight difference in the masses; and in the other two the mass of each secondary must be about 0·8 that of the main component. There seems, however, to be some slight evidence that the ratio is not constant, suggesting that the lines of a component increase in strength when it is approaching us in its orbit. The observations, the orbital elements and radial velocity curves deduced therefrom, and the reproductions of the photographed spectra, are given for each of the four binaries. M. A. E.

327. *Three Spectroscopic Binaries.* **J. S. Plaskett.** (Dominion Astrophys. Obs. Victoria, Publ. 3. 11. pp. 247–264, 1926.)—(1) *21 Cassiopeiæ.* Stebbins has found that the difference between the half-period and the interval from principal to secondary minimum is less than the thousandth of a day, showing that the eccentricity of the orbit is almost zero. The author finds evidence of the rotation of the bright component, and concludes that Algol variables, as a rule, have circular orbits, and that their rotation and revolution periods are the same. (2) He gives the spectrum and the elements of the orbit of *Boss 3354.* (3) For *H.D. 191201* he concludes that the temperature of the primary is 26,000 T, with a surface brightness of − 3·84, or thirty-four times that of the sun, and a probable density of 0·05. Its distance is at least 5000 light years, which is farther than the average O-type and much farther than distances previously ascribed to B-type stars. [See Abstract 500 (1925).] A. S. D. M.

328. *The Orbits of Two Double-Lined Spectroscopic Binaries.* **W. E. Harper.** (Dominion Astrophys. Obs. Victoria, Publ. 3. 12. pp. 265–273, 1926.)—The first of the two stars dealt with in this article, *Boss 1275,* is of type A0 and was announced as a double-lined binary by Adams of the Mount Wilson Observatory in October, 1916. A couple of years later Cannon, at the Dominion Observatory, Ottawa, determined its orbit from forty plates taken there with the single-prism camera. Unfortunately, as shown herein, the period of 27·43 days is incorrect, and the first half of this publication deals with the revision of the orbital elements of this star from plates made at Victoria. The revised period is 2·15165 days, and a circular orbit with semi-amplitudes of 113 and 130 km. per sec. gives a reasonably satisfactory agreement with the observations. The masses of the components multiplied by the cube of the sine of the inclination are respectively 1·7 and 1·5 times that of the sun. AUTHOR.

329. *Theory of the Radiative Equilibrium of Stellar Atmospheres.* **W. Becker.** (Ann. d. Physik, 81. 1. pp. 1–31, Aug. 30, 1926.)—The author's object is to improve upon Schwarzschild's theory of the radiative equilibrium of the solar atmosphere by taking into account the anisotropy of the radiation in various directions within that atmosphere. Schwarzschild's treatise deals only with one stream of energy outwards and one inwards, and takes no account of the dependence of the radiative intensity on the direction. A further object is to establish equations, allowing the introduction of boundary conditions into Eddington's theory of the radiative equilibrium of stars. The paper is entirely mathematical and deals with the following problems: (1) The differential equations of radiative equilibrium in spherically symmetrical order are established and integrated for strong absorption (considering four terms of the series). For the special case that the radiative field is bounded by two black spherical shells of small curvature (radius ρ) and small distance d, the constants are determined, and it is shown that the solution differs from that of the plane case only by terms of the order $\sqrt{\frac{d}{\rho}}$. (2) For the case of weak absorption the coefficient of emission and of the radiative intensity as far as the terms of the first order in the coefficient of absorption is calculated, showing that in this case also the solution differs from that of the corresponding plane problem only by terms of the order $\sqrt{\frac{d}{\rho}}$. An approximative method is given for calculating the stream of radiation. (3) The principle of radiative equilibrium is applied to the solar atmosphere, a formula given by Jaffé [see Abstracts 937 and 938 (1923)], which approximately holds good for any given degree of absorption, serving as a point of departure. The distribution of density in the solar atmosphere is found to differ somewhat from that given by Schwarzschild. The distribution of illumination on the sun's disc is recalculated, giving values agreeing more closely with observation than those of Schwarzschild. (4) The giant star calculated by Eddington of $M = 1 \cdot 5$ solar mass, radius $R = 7 \times 10^6$ km. and molecular weight $\mu = 2 \cdot 8$ is constructed (the discrepancies with Eddington's theory in the outer layers being taken into consideration), and the distribution of temperature and density found to differ somewhat from that given by Eddington. Several tables are given. E. F.

330. *Motions of Stars in Scattered Cluster N.G.C. 225.* **O. J. Lee.** (Roy. Astron. Soc., M.N. 86. pp. 645–650, Oct., 1926.)—The position of the east end of a pear-shaped structure, 44′ by 36′, is R.A. $0^h 37 \cdot 6$, Dec. + 61°15′; plates taken on 1903 Sept. 17 and 1925 Dec. 29. A photograph is given of the whole cluster, taken by Barnard, the part measured being enclosed in a rectangle. The cluster structure is probably confined to the brighter stars, and ten fainter stars in the plate were taken as comparison. A figure is given showing motions corresponding to a time interval of 13,800 years. Two stars are probably interlopers racing past on parallel courses, but the average motion of the other stars is $0''\cdot0149$ as compared with $0''\cdot0030$ of the comparison stars. Of the cluster, a northern group of stars (fifteen in number) move westwards, a southern group (five) lead eastwards, and an eastern group (six) move northwards, the remaining central stars being stationary as regards the comparison. Removal of the solar motion effect by correction of the parallactic motion of the 12th magnitude comparison stars does not, of course, alter the rotation effect shown by the group. The author asks for plates of the whole cluster if such are available. A. S. D. M.

331. *R. A. Sampson's Structure of the Solar Cluster.* **H. Kienle** and **P. ten Bruggencate.** (Roy. Astron. Soc., M.N. 86. pp. 651–657, Oct., 1926.)—Sampson [see Abstract 2302 (1926)] has plotted the number (N) of stars within and up to any assigned distance (D), and has obtained parabolæ of the third order near the origin, but having an inflection at a certain distance (D_i), finally converging to an asymptotic limit; and has concluded that these inflections and finite limits of the curves are real, and do not give a false clustering due to "visual extinction" from "distance effect." The authors show that the variation of D_i with M (mean absolute magnitude) and S (spectral class) may be qualitatively explained by the selection of the stars according to apparent magnitude and proper motion. Hess (in Astron. Nach. 220, p. 65) has shown that systematic errors entering into statistical investigations on the density and luminosity laws of stars near the sun by selection principles may be converted into *accidental* errors, and Sampson's distance effect should have been first eliminated according to Hess's method of weighting the star numbers, when perhaps no clustering would be evident. The authors also show qualitatively that Sampson's conclusions are improbable, since for a group of dwarfs of a given spectral class the material cannot be complete, though it may be so for the giants; for example, the parallax catalogues are more complete for the K- than for the A-dwarfs. Finally, the authors plot for each group, M against D_i, noting that if the "distance effect" consist of visual extinction merely, all points in the figure must lie on the straight line $M + 5 \log D_i = \text{const.}$, the constant being given by the apparent magnitude which indicates the beginning of the incompleteness of the material. But the difference between mere visual extinction and true distance effect is larger, the later the spectral type; and the later the spectral type, the more stars appear in parallax catalogues selected upon their proper motions, which in the case of mere visual extinction would pass out of the practical observing list. Sampson's solar cluster therefore is not actual, but is caused by an insufficient analysis of the problem of selection principles in practical astronomy. A. S. D. M.

332. *Centre of the Local Star System.* **E. A. Kreiken.** (Roy. Astron. Soc., M.N. 86. pp. 665–686, Oct., 1926.)—In M.N. 85, 499–507, and M.N. 85, 985–997, the distribution of the stars in the galactic plane and up to galactic latitude + 30° and − 30° was discussed, and the results indicated a markedly eccentric position of the sun in the local star system. In the present paper the distribution of all the stars in the whole sky down to magnitude 17 is investigated, the material being taken from the Harvard-Groningen Durchmusterung of Selected Areas and from the article of Seares, van Rhijn, Joyner and Richmond [see Abstract 945 (1926)]. Adopting as the centre of our local star system the place where the star density is greatest, its galactic coordinates are found to be long. 314°, lat. $-6°$, and distance 2270 parsecs. This eccentric position of the sun causes not only the latitude but the longitude to play an important part in the distribution of the stars, and the star density is less in the northern than the southern sky, because the sun is about 250 parsecs north of the galactic plane. Other irregularities in the distribution curves are due to star clouds and absorbing nebulæ. M. A. E.

333. *Method for Correcting Series of Parallax Observations.* **F. Dyson.** (Roy. Astron. Soc., M.N. 86. pp. 686–706, Oct., 1926.)—A formula of Eddington's makes it possible to infer the true distribution of parallaxes from the apparent, and from this the mean errors of parallaxes of different amounts can be obtained by a simple algebraic solution, also due to Eddington. This solution is here applied to parallaxes determined at Greenwich of stars having proper motions greater than 20″ a century, and also to Schlesinger's Catalogue of Parallaxes. The scarcity of stars with small proper motions is shown to be surprising, only two of the Greenwich stars having a velocity less than 20 km./sec.; and the velocities in Stream II are considerably less than in Stream I. The velocities of giant stars of later type are distinctly greater than those of earlier type, which is in accordance with results previously obtained from radial velocities. The method is applicable to all homogeneous series of observations in which the probable error is known, and is an appreciable fraction of the true range in the quantities determined. M. A. E.

334. *Spectroscopic Absolute Magnitudes and Parallaxes of 200 A-Type Stars.* **A. V. Douglas.** (Roy. Astron. Soc. Canada, J. 20. pp. 265–302, Oct., 1926.)—The spectroscopic absolute magnitudes and parallaxes of 200 A stars have been determined. The material used was the large collection of one-prism slit spectrograms of the Yerkes Observatory. Eighty stars having reliable trigonometric or cluster parallaxes were made the basis of calibration, and seven criteria have been found giving correlations with absolute magnitude, namely: width of K, Hδ, λ4481, and intensity ratios λ4215/λ4227, λ4233/λ4227, λ4535/λ4481, λ4549/λ4481. Relative to the standard stars, the systematic error of the magnitudes is $-0\cdot04$ and the probable error $\pm 0\cdot5$. Relative to 108 Mt. Wilson spectroscopic magnitudes the systematic error is $+0\cdot09$ and the probable error $\pm 0\cdot3$. The Shajn Double Star test applied to twelve pairs gives satisfactory evidence in favour of the accuracy of the magnitudes. The magnitudes show correlation with proper motion but not with reduced proper motion. A comparison is given between Mt. Wilson, Arcetri and the writer's average magnitudes for each spectral subdivision, and evidence is given in support of the claim that the magnitudes herein determined have greater individual accuracy than can be obtained by adopting the mean magnitude method. AUTHOR.

LIGHT.

335. *A Critical Survey of Modern Developments in the Theory and Technique of Colorimetry and Allied Sciences.* **J. Guild.** (Optical Convention, Proc. Part I. pp. 61–141; Disc. 141–147, 1926.)—Colorimetry is the application of measurements to the visual sensations produced by light. Such measurements consist of comparisons of the sensations produced by different stimuli, one of which produces the sensation under investigation and the other of which is of known character expressible in terms of some variable or variables which form the basis of a scale of measurement. Visual sensations depend on the amount and spectral distribution of the energy in the stimulus and on the properties of the receiving eye. No system of measurement can be true for every eye, and it is necessary to legislate for a " normal " eye, defined in terms of the essential properties which enter into *comparisons* of the various elements—luminosity and colour-quality—of a visual sensation. In this survey the writer reviews the available information on all matters relevant to colorimetric measurements, and endeavours to summarise, for the guidance of those engaged on such work, what may be regarded as the best practice open to them at the present time, while indicating the directions in which improvement is most urgently required, not only as regards colorimetric procedure as ordinarily understood, but also as regards the equally important auxiliary matters, such as the establishment of standards of known spectral energy distribution. The various sections of the subject are dealt with in the following sequence: Properties of illuminants; spectrophotometry; the photometric properties of the eye (methods of heterochromatic photometry, visibility curve of spectrum, etc.); laws of colour mixture (colour geometry and colour calculations); colour measurement (various methods of colorimetry); standard conditions for colorimetry (field size, brightness and " white " light); standard terminology. AUTHOR.

336. *Colour in Relation to Printing.* **W. Gamble.** (Optical Convention, Proc. Part I. pp. 159–163; Disc., 163–165, 1926.)—The great progress made in recent years in the application of the trichromatic principle to the photography of coloured objects for reproduction purposes has made exacting demands on manufacturers of printing inks. But, though innumerable colour charts, systems and forms of colour-testing apparatus have been put forward, none has come into practical use. Inkmakers prefer to rely on experience and skill gained by constant practice in comparing requirements with test patches. Valuable as scientific apparatus can be for securing standardised results in numerical terms, it would seem possible to arrive at some degree of standardisation without elaborate apparatus if all inkmakers could be induced to agree on a common method of matching, based on the use of a standard illumination, viewing the test patches against the colours to be matched in an enclosed box from a fixed distance and employing standardised viewing filters. Though not yielding information in numerical terms as to the amount of correction necessary, inkmakers no doubt have the necessary experience to know how to adjust their colours until an exact comparison is obtained. AUTHOR.

337. *Some Peculiarities of Selective Absorption and their Effects in Technology.* **A. J. Bull.** (Optical Convention, Proc. Part I. pp. 185–188, 1926.)—Most colours produced by selective absorption of light are characterised by the presence in varying quantities of all visible light. Only in the cases of some bright yellows, oranges and reds is the light of one region of the visible spectrum transmitted in high proportion, while other regions are completely absorbed. The effects of this phenomenon on colour photography, colour printing and the primaries used for colour measurement are discussed. AUTHOR.

338. *Colour Problems in the Woollen and Worsted Industries.* **S. G. Barker** and **H. R. Hirst.** (Optical Convention, Proc. Part I. pp. 189–208; Disc., 208–210, 1926.)—The paper deals with two main subjects: (1) The provision of a daylight lamp for the determination of the fastness or fugitiveness of dyes; (2) the method of fixation of definite standard specifications for shades and colours. Under the first heading a survey of the present position with reference to daylight fading lamps is given. The precise requirements for such a lamp are stated and the defects of the lamps available at present are discussed. A method of comparison of the energy distribution in the spectra of various sources of light is given. Tables are incorporated showing comparisons of fading of dyes over a large range of shades and colours obtained by the authors in experiments with sunlight and the carbon arc. Further tables of photometric measurements relating to sunlight fading are given. The present position regarding the chemical aspect of fading is surveyed fully. The problems of accurate colour and shade definition and measurement, the influence of water vapour, the effect of temperature variation, and the general influences of external conditions on fading are put forward as they affect the textile trade. AUTHORS.

339. *An Optical Illusion due to Contrast.* **G. P. Thomson.** (Cambridge Phil. Soc., Proc. 23. pp. 419–421, Oct., 1926.)—A description is given of a number of curious contrast effects observed in positive-ray photographs. On the negative a rectangular image is formed of approximately uniform blackness as measured with a microphotometer, and on either side of this image scattered rays give rise to two wings of graduated blackness. It was observed that the edges of the rectangle always appeared blacker than the centre, the effect varying with the amount of the "scattered" blackening. The interpretation advanced is that the eye sees rapid change of blackness, on a light background, as enhanced blackness. W. S. S.

340. *The Mathematics of Colour Vision: Threshold Values and their Uses.* **W. Peddie.** (Optical Convention, Proc. Part I. pp. 225–231; Disc., 231–237, 1926.)—There are three, and only three, independent ways in which two lights which are entirely identical can be made to appear different to the eye. They may be made to differ in respect of intensity or brightness, of colour or hue, or of depth or purity of colour. We may vary the set of three variables, or even add to them, but, as Helmholtz long ago pointed out, we cannot find more than three which are independent. In the first part of the paper the laws which regulate intensity and colour composition are discussed, together with the threshold values—that is, the just perceptible values of the external stimuli. The threshold values take account of all causes of variation in the sensation which is produced by a given fixed external stimulus. The sensation-value of the external stimulus—that is, its effectiveness towards the production of sensation—is thus also introduced. The second part of the paper deals with the form of the relation which expresses the threshold value in terms of the external stimulus which affects it. This expression is then generalised, so as to take account of inter-relation of effects and of the influence of any given fatiguing light to which the eye may have been previously exposed. This generalisation is then shown to furnish an explanation of the peculiar effects of strong precedent fatigue upon the sensitiveness of the eye to spectrum colours, which has been investigated in detail by F. Allen. AUTHOR.

341. *Notes on Silica Glass.* **(Lord) Rayleigh.** (Optical Convention, Proc. Part I. pp. 41–46; Disc., 46, 1926.)—The question is discussed why silica glass made from sand is only translucent, while the silica glass made from rock crystal is transparent. The difference is shown to depend on the fact that sand grains when heated develop gas bubbles internally. This behaviour is traced to the geological conditions attending the formation of the material. Sand grains form the residuum when granite is weathered away, and granite is formed under great pressures and contains water and carbon dioxide. Plates of silica glass are examined by a photographic method dependent on the same principle as the Töpler-Foucault knife-edge test. The photographs show a structure of small grains about 1/10 mm. diameter, immersed in an apparently homogeneous matrix. When the grains are numerous, the specimen is optically bad, and destroys the definition of a telescope when held over the object glass. A quite different and usually much coarser structure is shown by polarised light, as described in a former paper. This latter appears to be much less closely related to the optical quality of the material, the double refraction probably being small compared with the differences of single refraction brought into evidence by the knife-edge method. The transparency of silica glass to ultra-violet light is markedly inferior to the transparency of the rock crystal from which it is made, if specimens 3 cm. thick are compared, in the region λ1850. No difference was traceable between Brazilian and Madagascar crystal, nor between the glasses made from each. The glass made from sand is much inferior in transparency to these, but transmits to about λ2400 in pieces 5 mm. thick. AUTHOR.

342. *A New Instrument for Investigating Colour Vision.* **R. A. Houstoun.** (Optical Convention, Proc. Part I. pp. 148–152; Disc., 152–154, 1926.)—If the colours are arranged after the manner of Maxwell and Helmholtz on a triangle diagram with the primaries red, green, and blue at the corners, an observer's power of discriminating colour differences can be represented by contour lines on this diagram. If he can distinguish small differences, these contours will be close together. If his power of discriminating colour is weak, they will be far apart. Also, from the run of the contour lines, it is possible to deduce facts about the observer's colour vision.

The new instrument is designed for obtaining such contour lines. As primaries, Wratten and Wainwright's standard tricolours are taken. The observer looking into the instrument sees two patches of the same colour; then the second of these patches is gradually altered in colour until the difference is just perceptible. The colour of the first is next adjusted until the colours are the same again. This concludes one step. Then the operation is repeated for a second step, and so the whole number of steps measured which are required, for example, to go from the red corner to a point on the blue-green side of the diagram. The alteration in colour is produced by drawing coloured filters across an object glass. AUTHOR.

343. *A Colour Vision Spectrometer.* **W. Peddie.** (Optical Convention, Proc. Part I. pp. 155–158; Disc., 158, 1926.)—It is desirable that, in the use of apparatus for the purpose of establishing colour matches, forming comparison spectra, determining the form of sensation curves, the form of sensitivity curves, or generally for the evaluation of visual data, all portions of the light employed should be treated in as nearly as possible the same manner. It is also desirable that estimates of intensity should be easily and directly attainable. The apparatus described in this paper is intended to satisfy these conditions. It is not intended to be the simplest form of apparatus working on the principles involved. It is intended rather for purposes of investigation in a variety of directions and under various conditions. The main collimator is provided with two compound lenses, the second of which produces a parallel beam of light, while the first forms a real image of the main slit between the two lenses. The special feature of these lenses is that they are each divided into two semi-lenses by a plane passing through the axis, as in the heliometer. The method of use varies according as to whether intense or comparatively weak light is under observation, a diffusion plate being placed at the focus of the first lens in the former case, and biprisms being attached to the halves of the second lens in the latter. Intensities are measured by means of sectors which diminish the effective areas of the semi-lenses. [See also Abstract 68 (1926).] AUTHOR.

344. *Some Visual Factors Affecting the Use of Optical Instruments.* **L. C. Martin.** (Optical Convention, Proc. Part I. pp. 166–181; Disc., 182–184, 1926.)—Progress in the methods of use of observational instruments requires a study of the properties of the eye. The relation of the sizes of the visual elements in the retina, to the possible three-dimensional extension of the elementary image, is discussed, and also the factors affecting the various forms of visual acuity. The conditions governing the phenomena of the visual threshold were studied in 1917, especially with reference to the problem of night glasses. Experience in this work led to further experiments on the difference limen of contrast perception at the fovea, as affected by the stimulation of peripheral retinal regions; a brief account of the various results is presented, and some possible applications are indicated. In particular, such questions are of importance in determining the best size of field for use in observational instruments under various conditions, and the results of some preliminary experiments on this matter are given. AUTHOR.

345. *Colour Tests by Means of Lovibond's Tintometer.* **F. E. Lovibond.** (Optical Convention, Proc. Part I. pp. 211–213; Disc., 213–214, 1926.)—Description of Lovibond's tintometer as an instrument by means of which the colour of all solids, liquids and gases can be accurately measured in degrees on a permanent colour scale and registered for reproduction at any time, the colour scales being filters of red, yellow and blue graded standards, these having been found to be the only colours suitable for systematic work. Their accordance with Rood's divisions and the correlation of the scales with wave-length values. The ideal light for colour work and the difficulties of suitable artificial lights —the practical uses of the tintometer—details of three special sets of apparatus, *i.e.* (1) an artificial light reflector for use with the standard colours used in estimating the colours of merchantable petroleums; (2) colour perception and colour blindness tests provided with twenty-six colour filters; (3) a radiomèter for use with Sabouraud's pastilles, for use in X-ray therapy, for the exact measurement of fractions and multiples of the erythema dose. AUTHOR.

346. *The Theatre Mutochrome.* **C. F. Smith.** (Optical Convention, Proc. Part I. pp. 215–224, 1926.)—The paper describes the mutochrome and its application to the projection of stage scenery. The problems involved in reduced scale photography in the studio and normal projection at the theatre are discussed, and a suitable camera and projector are described. AUTHOR.

347. *Measurement by Optical Projection.* **G. A. Tomlinson.** (Optical Convention, Proc. Part I. pp. 311–326, 1926.)—The paper commences with a brief history of the development of the method of projection at the National Physical Laboratory, leading on to a description of the two types of apparatus, horizontal and vertical, of N.P.L. design now widely used. A series of examples are then given, illustrating the wide range of utility of the apparatus. Other projection apparatus of British manufacture is described, including the Wilson screw thread projector and the Beck projection microscope for fine wire measurement. In conclusion the theory of the formation of the image is considered briefly. AUTHOR.

348. *Determination of the Extinction Coefficients of Optical Glasses for Light in the Visible Spectrum.* **W. D. Haigh.** (Optical Convention, Proc. Part I. pp. 327–345; Disc., 346, 1926.)—In order to be able to determine the extinction coefficients of pieces of glass not more than 6 in. in thickness, the apparatus described in the paper was made up and has proved quite satisfactory. This apparatus is a modification of one designed by G. M. B. Dobson, and its design and mode of operation are based on the principles which he adopted. A single beam of light is used into which either of two pairs of neutral wedges can be introduced and the two pairs of wedges are mounted parallel to each other, one pair being above the other. The beam of light enters a photoelectric cell which is connected to an electrometer, etc., in such a way that variations in the intensity of the light will alter the reading of the electrometer. The essential adjustment throughout the experiments is to make the electrometer have the same deflection whichever pair of wedges is in the path of the beam. If the two pairs of wedges are "balanced" against each other in this way initially, and then a block of glass is placed just behind the lower pair, the balance will be disturbed. To restore it, one of the upper wedges must be moved across the other to increase the amount of light absorbed by this pair. When the balance has thus been restored, the distance through which the upper wedges have been displaced relative to each other is measured, and the corresponding reduction in the intensity of the transmitted light is calculated from the "gradation factor" of this pair of wedges. This reduction is evidently equal to the amount by which the block of glass reduces the intensity of the beam transmitted by the lower wedges when these and the glass block are in the path of the beam. With readings taken on two different lengths of a glass, one a ½-in. piece and the other between 4 in. and 6 in. long, the extinction coefficients can be determined to within 0·05 % per in. of glass. AUTHOR.

349. *Optical Instruments for Investigation in the Infra-Red and Ultra-Violet.* **C. Leiss.** (Zeits. f. Physik, 39. 5–6. pp. 465–472, 1926.)—(1) An infra-red spectrometer is described which has steel mirrors, a rock-salt prism and a drum measuring wave-lengths working at intervals of 0·1μ over the range 0·3–15μ. The surfaces of the rock-salt must be kept dry and well polished. With a prism of 60° there is a dispersion of 8° from the Na line to 15μ. (2) A monochromator with quartz optical parts and automatic focussing of the lenses is explained. This gives a dispersion of 17·5° over the region 0·2–4·2μ. (3) An ultra-violet double monochromator is described with quartz optical parts, prisms of 60° and lenses with automatic focussing. The system has a dispersion of 9°45′ and works over the region 0·2–0·5μ. R. S. R.

350. *Control of Parabolic Mirrors by Hartmann's Method.* **(Miss) M. Romanoff.** (Rev. d'Optique, 5. pp. 341–362, Sept., 1926.)—A divergent pencil from a luminous point is used at a finite distance from the mirror and the necessary corrections applied for a parallel pencil. If the aberrations are known for a finite distance they can be calculated for an object of any distance. The objections are a lack of speed and precision. From these calculations are deduced the difference between the form of the mirror examined and a special paraboloid called the "nearest" paraboloid. The quality of the image, or more exactly its intensity at the centre, was characterised by the maximum amplitude of the error. The representative curves of these errors, as a function of the radius of the corresponding zone, give a rapid measurement for the correction of the mirrors. Full details are given of the optical arrangements employed. The errors between the mirror and the paraboloid reach a precision of 0·00008 D/F mm., where D is the diameter and F the focal length of the mirror. The method has been employed successfully in controlling and correcting a series of ten mirrors while under construction in Leningrad. R. S. R.

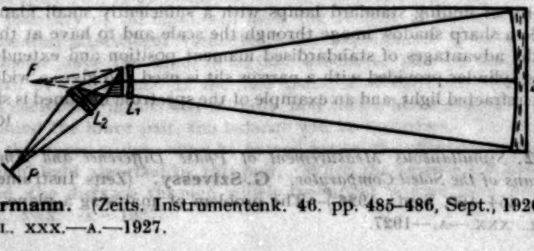
351. *Wide Angle Illuminator.* **C. F. Smith.** (Journ. Sci. Instruments, 4. pp. 18–21, Oct., 1926.)—The arrangement described is to meet the difficulty of finding standard lamps with a sufficiently small filament to provide a sharp shadow image through the scale and to have at the same time the advantages of standardised filament position and extended life. A glass cylinder provided with a narrow slit is used and gives a wide angle for the refracted light, and an example of the spectrum obtained is shown. R. S. R.

352. *Simultaneous Measurement of Phase Difference and Amplitude by Means of the Soleil Comparator.* **G. Szivessy.** (Zeits. Instrumentenk. 46. pp. 454–460, Sept., 1926.)—The problem of analysing a plane, monochromatic, elliptically polarised light wave is solved when the position and shape of the ellipsis of vibration have been determined. The treatment is mathematical. An illustration of the apparatus is given E. F.

353. *Direct Stereoscopic Visualising of the Fine Structure of Bodies, Especially Crystals.* **H. Herbst.** (Zeits. Instrumentenk. 46. pp. 460–468, Oct., 1926.)—It has been found that the shorter the wave-lengths of the illuminating rays the finer are the objects or structures which can be made visible. As the visible and the ultra-violet rays are inoperative with objects of less than 0·00010 mm. it was necessary to seek for shorter wave-lengths, and X-rays were found to be suitable, their wave-length being 20 to 50,000 times smaller than that of the middle ultra-violet rays with a wave-length of 250$\mu\mu$. It having been hitherto assumed that the distance of the atoms from each other is approximately 10^{-7} mm. = 0·1$\mu\mu$, the wave-length of the X-rays lies well within this limit. It should therefore be possible to lead the X-rays through the interatomic spaces, the so-called "atomic lattices," as indeed was demonstrated by Laue in 1912 (Laue diagrams). The principle of the method here described, and illustrated by figures, which should be consulted in the original, consists in combining the action of X-rays or still shorter rays with that of ordinary or ultra-violet rays in such a manner that the visible or ultra-violet rays simultaneously or successively follow the same path in the same or contrary direction as the X-rays which are deflected or diffracted on the object. Adopting the usual procedure of the binocular microscope, the visible or ultra-violet rays are then led to form a binocular stereoscopic image of the fine structure of the body. As we are here in the region of atomic magnitudes, such an instrument may be called an atomic microscope. E. F.

354. *Autocollimation Method of Testing Prism Angles.* **W. Uhink.** (Zeits. Instrumentenk. 46. pp. 469–476, Sept., 1926.)—When a beam of light traverses a prism, part is reflected at each face, and these reflected beams may be used for measuring the angles of the prism. A parallel beam is produced by means of a telescope with an autocollimated ocular, and this beam is caused to enter the prism in a suitable direction so that it suffers internal reflections and, if the prism is perfect, returns on its original path. The displacement of the image formed by this reflected beam gives a relation between the errors in the prism angles. By making a sufficient number of determinations of this kind, with different positions of the prism, the values of the individual errors may be found. J. W. T. W.

355. *Quartz Star Spectrograph without Spectrum Displacement.* **B. Meyermann.** (Zeits. Instrumentenk. 46. pp. 485–486, Sept., 1926.)—In



the ordinary spectrograph it is necessary to incline the plate or use a curved film. In the apparatus shown in the figure this is not necessary. The convergent beam reflected from S is made parallel by the concave quartz lens L_1 placed with its focus at F. The parallel beam passes through the quartz prisms, is dispersed, and is then brought to a focus on P by the lens L_2, which is complementary to L_1, so that the pair act simply as a plane parallel plate. J. W. T. W.

356. *Investigations of Accuracy when Determining Angles.* **Löschner.** (Zeits Instrumentenk. 46. pp. 497–519, Oct., 1926.)—The author carried out a series of measurements of angles with four types of instrument: (1) The old form of optical square which had been previously tested for accuracy, (2) and (3) two forms of a Hensoldt cross-viewer, and (4) a Schellen sharp-angled pentagon. Details are given of the optical arrangements. From the observations tables are constructed giving the accidental and constant errors for each of the four types. The small constant errors are not due merely to faulty cutting of the instrument, but may arise from its method of support, from illumination, from the method of marking the centre and other circumstances of observation. For the Hensoldt cross-viewer and for Schellen's pentagon the mean accidental error lies between 1′ and 2′. Working with either of these forms is easy, convenient and exact, and one gets sharp, bright images, while a surprisingly large angle of view is possible. Notes are given regarding the best method of working for large angles of view. R. S. R.

357. *Fibre Testers.* **C. Pulfrich.** (Zeits. Instrumentenk. 46. pp. 533–535, Oct., 1926.)—An account of Zeiss's new table lenses and comparison-microscopes for examining and comparing fibres and fabrics. A. D.

358. *Microscopic Examination of Metallic Minerals.* **J. Orcel.** (Rev. de Mét. 23. pp. 537–551, Sept., and pp. 618–626, Oct., 1926.)—This paper gives a general account of the technique involved in the microscopic examination of certain minerals. It deals with the usual problems of polishing and etching and gives a full account of the methods to be adopted when using normal, oblique and polarised light. There are also brief notes on other properties of minerals, such as hardness, electrical conductivity, etc. To illustrate the methods some examples are given of observations upon typical minerals. A. A. D.

359. *Light Sources for Use in Polarimetry.* **P. C. Austin.** (Optical Convention, Proc. Part I. pp. 305–310, 1926.)—Flame spectra have been to a great extent superseded by the more brilliant arc spectra in polarimetry, since the latter can be used not only for measuring rotatory power, but also for measuring rotatory dispersion. The ideal source of light for this work is the enclosed metallic arc. All lines, whether from flames or from arcs, must be purified spectroscopically. This is usually done at the eyepiece, though for big rotations a preliminary purification must be effected by means of a constant deviation spectroscope before the light enters the polariser. Light filters are unsuitable for accurate readings. To obtain data for the mathematical analysis of dispersion curves three pairs of lines are recommended as standards, *viz.*: (1) the green and blue lines of mercury at $\lambda = 5461$ and 4359 Å.U.; (2) the red and green lines of cadmium at $\lambda = 6438$ and 5086 Å.U.; and (3) the red and blue lines of lithium at $\lambda = 6708$ and 4602 Å.U. The first two pairs can be read with the aid of enclosed arcs, which also yield some other lines of relatively less importance. The lithium lines can be obtained by introducing lithium carbonate between the electrodes of a silver or copper arc. The sodium line can be read at the same time. Other available lines are provided by the copper and brass arcs, and the iron arc is used for extending the observations into the ultra-violet region photographically. Altogether twenty-three visible lines can be used at present. AUTHOR.

360. *Main Points of Divergence between Electromagnetic and the Quantum Theories of Light.* **F. A. Lindemann.** (Optical Convention, Proc. Part 1. pp. 17–20; Disc., 20–23, 1926.)—In this paper all that is intended is to give a brief *résumé* of the position of the two rival theories of light, the undulatory and the emission theory, or the electromagnetic and the quantum theory; it is not claimed that a solution of the outstanding difficulties and discrepancies has been found or even indicated. AUTHOR.

361. *Doppler's Principle and the Ballistic Hypothesis.* **O. M. Corbino** and **T. Levi-Civita.** (Accad. Lincei, Atti, 3. pp. 705–714, June 20, 1926.)—The ballistic hypothesis postulates that the velocity of light is given by the vector sum of the normal velocity of light and the velocity of its source. On this theory Doppler's principle will still hold in a modified form, and a similar effect due to acceleration of the source will occur. In this paper expressions are developed for the form of Doppler's principle required on this hypothesis, and certain cases are worked out. In the case of the Doppler effect due to a double star a wide difference between classical and ballistic effects is to be expected. A. Wh.

362. *Doppler's Principle and the Ballistic Hypothesis.* **F. Wataghin.** (Accad. Lincei, Atti, 4. pp. 138–145, Aug., 1926.)—Corbino and Levi-Civita have concluded that a "Doppler effect of acceleration" would be prominent in certain cases of double stars on the ballistic theory of light [see preceding Abstract]. The author criticises the definition of frequency adopted, and shows that it is possible to construct a theory which is in consonance with observation. A. Wh.

363. *A Polarised Light Quantum.* **J. M. Whittaker.** (Roy. Soc. Edinburgh, Proc. 46. 3. pp. 306–313, 1925–1926.)—Thomson and Whittaker [see Abstracts 1620, 1621 (1926)] have shown the possibility of quanta consisting of closed rings of electric force, propagated normal to the plane of the ring, provided Maxwell's equations are modified by the introduction of a magnetic density μ analogous to electric density. The present paper works out other possible types of quanta and in particular a polarised quantum for which the lines of force form two sets of closed contours, these sets being symmetrically arranged about a central line. The orientation of the line of symmetry would correspond to the position of the plane of polarisation. The conditions of reflection and refraction for normal incidence at a plane dielectric surface are investigated and the Fresnel law verified. By considering the reflection of a ring quantum at a moving mirror it is shown that for quanta of the same shape a parameter ν must be introduced which is proportional to the energy of the quantum and plays the part of the frequency of the light. W. S. S.

364. *Intensities of the Zeeman Components in the Partial Paschen-Back Effect.* **Lucy Mensing.** (Zeits. f. Physik, 39. 1. pp. 24–28, 1926.)—The intensities are calculated for certain doublets and triplets, making use of quantum mechanics, following the method of Heisenberg and Jordan [see Abstract 2372 (1926)]. In agreement with the observations of Back, certain inner components of the combination $^3P_1^3D$ fall out, and also different outer components. The calculated intensities of the several groups agree quantitatively with the measurements. H. N. A.

365. *Stark Effect of the Second Order for Hydrogen and the Rydberg Correction for the Spectra of He and Li.* **I. Waller.** (Zeits. f. Physik, 38. 8. pp. 635–646, 1926.)—The Schrödinger wave equation for a hydrogen atom in an electric field is solved by a method which leads to expansions of the characteristic energies in terms of powers of the field intensity. The result obtained for the coefficient of the square of the field intensity only differs appreciably for small quantum numbers from that given by Epstein. The experimental data available are scarcely sufficient to decide between the two results, but if anything the new formula agrees more closely with the observations. The Rydberg correction for a system consisting of a nucleus and two electrons, of which one moves in the ground orbit and the other in an outer orbit, is evaluated by a device making use of the formula obtained for the second order of the Stark effect. A satisfactory agreement with observation is obtained. W. S. S.

366. *Fine Structure and Wave-Lengths of the Balmer Lines.* **W. V. Houston.** (Astrophys. J. 64. pp. 81–92, Sept., 1926.)—A Fabry-Perot interferometer was used to eliminate distortion by neighbouring components and to measure absolute wave-lengths. The first three lines of the Balmer series in hydrogen at the temperature of liquid air have been studied. Each line is a doublet with the differences of wave-number 0·315 for Hα, 0·331 for Hβ, and 0·353 for Hγ. The absolute wave-lengths are 6562·852 and 6562·716 for Hα, 4861·362 and 4861·284 for Hβ, and 4340·497 and 4340·429 for Hγ. These values give the Rydberg constant as 109677·70 ± 0·04. The doublet separation decreases and the intensity of the component of short wave-length increases with an increase of current. The doublet separation in the light from the end of the tube is greater than in that from the side when the current is high enough. The light from the side shows the corresponding polarisation. The observations may be explained by assuming that those forbidden components for which $\Delta k = 0$ are present are polarised with the electric vector parallel to the tube, and increase in intensity with an increase of current. AUTHOR.

367. *Intensity Relations of the Components of the Apparent Doublets of Helium.* **D. Burger.** (Zeits. f. Physik, 38. 6–7. pp. 437–439, 1926.)—According to Sommerfeld's rule, the helium spectrum should contain only singlets, triplets, quintets, etc. In practice, however, doublets are found, but, as Ornstein and Burger point out, the intensity ratio of the components differs widely from the normal doublet value, 1–2. The present experiments show that for six doublets ($2p-nd$, $2p-ns$ [$n = 3, 4, 5$]) the weaker line has an intensity about 13 % of the stronger. This corresponds to the ratio 1–8, and as the intensity ratio for triplets is 1–3–5 it is suggested that the apparent doublets are in reality triplets, two components of which have remained unresolved. W. S. S.

368. *Analysis of Line Spectra.* **A. Fowler.** (Nature, 118. pp. 593–596, Oct. 23, 1926. From the Presidential Address delivered to the British Assoc., Oxford, Aug., 1926.)—A summary of present-day knowledge concerning line spectra, with special reference to the theoretical and experimental advances made in the last four years. F. S.

369. *Time Interval between the Appearance of Spectrum Lines in Spark and in Condensed Discharges.* **J. W. Beams.** (Phys. Rev. 28. pp. 475–480, Sept., 1926.)—The experimental method consisted essentially in a comparison of the time interval elapsing between the appearance of two spectrum lines with the time required for light to travel a measured distance. The time intervals between the appearance of the bright visible spectrum lines of cadmium, magnesium and zinc in the spark in air and nitrogen and hydrogen in condensed discharges at various pressures were measured. The results indicate that the time between the appearance of these lines is due to atomic phenomena, and emphasise the importance of the final energy levels as well as the initial energy levels in determining the average time between excitation and the beginning of emission.
AUTHOR.

370. *Wave-Length Standards in the Extreme Ultra-Violet Spectra of Carbon, Nitrogen, Oxygen and Aluminium.* **I. S. Bowen** and **S. B. Ingram.** (Phys. Rev. 28. pp. 444–448, Sept., 1926.)—The wave-lengths of lines in the extreme ultra-violet spectra of carbon, nitrogen, oxygen and aluminium have been determined with an accuracy of 0·01 to 0·04 Å. by direct comparison with iron standards, and the pp' groups of carbon C_{III} and nitrogen N_{IV} have been completely resolved into six components and the ratio p_1p_2/p_2p_3 found to be 2·47 and 2·33 respectively.
AUTHORS.

371. *Absorption Spectrum of Hydrogen Iodide in the Ultra-Violet.* **K. F. Bonhoeffer** and **W. Steiner.** (Zeits. phys. Chem. 122. pp. 287–292, Aug. 9, 1926.)—If the primary photolytic process were a molecular activation (Stern and Volmer), the absorption spectrum should be a pronounced band spectrum; if there were primary dissociation of the molecule, the absorption area should be continuous. As the study of absorption spectra by means of spectrum lines as sources of light [Warburg, Abstract 879 (1918)] cannot discriminate between the two views, the authors used for their investigation, by means of a Hilger quartz spectrograph and the concave Rowland grating of the Reichsanstalt, a Gehlhoff aluminium lamp [Abstract 431 (1921)] or a continuous Gehrcke-Lau tungsten lamp [Abstract 1884 (1925)]; the stream of pure HI gas was kept at low pressures of 0·25 to 25 mm. Hg. The spectrum proved continuous between 3000 and 2300 Å. Other experiments with a Steinheil quartz spectrograph showed that the absorption set in near 2800 Å. and became complete below 2300 Å. H. B.

372. *Breadth of Absorption Lines in Irradiated Sodium Vapour.* **W. Kuhn.** (Zeits. f. Physik, 38. 6–7. pp. 440–442, 1926.)—In order to explain dispersion phenomena it may be assumed that atoms in a radiation field become sources of secondary wavelets. It is suggested that an atom acting as a secondary source in this way may perhaps acquire an additional energy proportional to the square of the amplitude of the oscillation induced in it, which by the Bohr frequency condition would be evidenced by a broadening or displacement of its absorption lines. In the experiment described, sodium vapour at 250° C. is powerfully irradiated with light containing only wave-lengths the distance of which from the D-lines lies between 0·06 and 0·03 Å. The absorption of the D-lines in the sodium vapour was observed visually with the external irradiation alternately on and off. No broadening or displacement was observed. A calculation of the effect to be expected indicated a displacement of the D-lines by 0·15 Å. W. S. S.

373. *O and N Characteristic Series of Low Frequency.* **A. Dauvillier.** (Comptes Rendus, 183. pp. 656–658, Oct. 18, 1926. Nature, 118. p. 551, Oct. 16, 1926.)—By the method previously used [see Abstract 2870 (1926)] the O and N series of thorium have now been explored. A special filament of thorium, prepared by de Boer, was used, and good photographs obtained in three hours with 25 mA and 2800 volts. A table is given of the observed wave-lengths up to 121 Å., together with the designations of the lines and the combinations from which they result. It is claimed that this forms the first union with Millikan's results in the extreme ultra-violet. F. S.

374. *The Series of the Argon Arc Spectrum. Part I.* **K. W. Meissner.** (Zeits. f. Physik, 39. 2–3. pp. 172–190, 1926.)—The existence of ten series in the "red" argon spectrum is proved, these series being analogous to the 10 *p*-series of neon. The series fall into two groups, belonging to two different limits. The distance between these limits is calculated to be 1423 cm.$^{-1}$. The paper contains table of wave-lengths and *p*-terms of argon. W. V. M.

375. *Self-Reversal of the Red Hydrogen Line.* **R. W. Wood.** (Phil. Mag. 2. pp. 876–880, Oct., 1926.)—Experiments to obtain the resonance radiation of hydrogen not proving successful, an attempt was made to see under what conditions the radiation from a strongly excited tube was absorbed by a feebly excited one. It was discovered in the course of the work that when the current employed was sufficiently great, and the components of H_α had broadened into one wide hazy line, sharp darker lines appeared in the position of the two components, in the absence of the second tube. The tube was viewed end on, and in such a case the intensity increases to E/A as the depth of the radiating layer increases, reaching this value for moderate depths, and then being practically unaffected by increased depth. This is the intensity of the *dark* lines—dark by comparison with the brighter hazy line only. Now A is less for neighbouring wave-lengths than for those of H_α, so that this maximum intensity is greater, and the "self-reversal" is explained. W. G. B.

376. *Absorption Spectra and Heat of Dissociation of Halogen Molecules.* **H. Kuhn.** (Zeits. f. Physik, 39. 2–3. pp. 77–91, 1926.)—The limits of absorption bands of Br and Cl are measured and arranged in a series scheme. The alteration of the spectrum with temperature was investigated and a connection found between the position of the absorption maxima and the nature of the linkage. The heats of dissociation were calculated with great accuracy from optical data. W. V. M.

377. *Effect of Helium on the Intensity of the Mercury Spectrum.* **W. G. Nash.** (Science, 64. p. 190, Aug. 20, 1926.)—The intensity of the mercury lines is increased by the admission of He to the discharge-tube, the charge increasing with the pressure of the helium. Below the helium pressure of 0·024 mm. types of irregular intensity changes occur. Of the nine lines examined, in eight cases (the exception being 3663) the increase in intensity from helium pressures 0·03 mm. upwards is greater at the impact energy of 19 volts than for 99 volts, *i.e.* inert helium produces a greater increase than radiating helium. Beyond 0·06 mm. both produce the same change in the intensity. W. V. M.

378. *Absorption Limits of Lutecium, Ytterbium, Erbium and Terbium.* **C. E. Eddy.** (Roy. Soc. Victoria, Proc. 38. pp. 1–12, 1926.)—The L-series absorption wave-lengths of lutecium, ytterbium, erbium and terbium have been measured relative to standard lines. A comparison has been made between the absolute determinations of the wave-lengths of the K emission lines of copper and some of the L lines of tungsten. A metal X-ray tube, with a thin window, and capable of operation at 30 kV and 30 mA has been devised. The values obtained for the absorption limits have been compared with those interpolated by Bohr and Coster. The bearing of these results on the binding energy of electrons in the 5_2 orbits is briefly discussed. W. V. M.

379. *Absorption and Series Spectra of Nickel.* **A. L. Narayan** and **K. R. Rao.** (Phys. Soc., Proc. 38. pp. 354–362, Aug., 1926.)—The paper gives an account of the experiments on the absorption spectrum of nickel by the underwater spark from λ6000–λ2000. In the region λ3800 to λ2100, 180 wave-lengths were obtained in absorption. The majority of these lines were classified by Bechert and Sommer. Intensity values of the absorbed lines showed that the intensity rule and the selection rule for inner quantum numbers were accurately fulfilled. The results confirm in a striking manner the recent classifications of Bechert and Sommer in the arc spectrum of nickel. AUTHORS.

380. *Arc Spectrum of Copper.* **A. G. Shenstone.** (Phys. Rev. 28. pp. 449–474, Sept., 1926.)—The arc spectrum of copper is partly an ordinary doublet spectrum with lowest term $^2S = 62308 \cdot 0$, and partly a complicated spectrum with lowest term $m^2D_3 = 51105 \cdot 5$ and $m^2D_2 = 49062 \cdot 6$. The next lowest terms of the complicated spectrum are ^4P, ^4F, $^4D'$, ^2F, ^2P, $^2D'$ in the order given, extending from $^4P_3 = 23289 \cdot 4$ to $^2D'_3 = 15709 \cdot 7$. They combine with ^2S and m^2D. The quartets are all inverted, while the doublets are not. There are eleven higher terms, which include amongst others a second set ^2F, ^2P, $^2D'$. This is all as predicted by the Heisenberg-Hund theory. Most of the lines of the arc spectrum are due to the combinations of the above quartets and doublets with a set of terms having negative wave-numbers extending from $-95\cdot2$ to $-14772\cdot4$. In particular, the lowest four negative terms are a complete ^4D, and form by combination with ^4P, ^4F, $^4D'$ multiplets of great intensity in the visible. The other negative terms include a set ^4S, $^4P'$, ^4D, $^4F'$, ^4G, which also combine with considerable intensity with the first-mentioned quartets. The limit of the negative quartet terms can be calculated to be at roughly $-22{,}000$. This should be the lowest spark ^3D term. The nature of the quartet spectrum was partly determined from Zeeman effects in the ultra-violet below 2500. The g-values of many of the terms are irregular, but the g-sums are correct. Line intensities were used mainly as criteria for the designation of terms. Unresolved Zeeman effects give confirmation in many cases. The two types of spectra are connected by combinations of the lowest terms of each with higher terms of the other. Other theoretically possible combinations do not occur.

AUTHOR.

381. *Arc Spectrum of Lead.* **N. K. Sur.** (Phil. Mag. 2. pp. 633–642, Sept., 1926.)—With a view to obtaining the higher members of the Rydberg sequence in the series spectrum of lead, the spectrum has been re-investigated, using the heavy-arc method of Hemsalech and de Gramont. Several members of the series $2s\text{–}mp_{1,2}$ and $2x\text{–}mp_{1,2}$ have been obtained, and indications that the arc spectrum of lead contains negative terms similar to those discovered by Russell and Saunders in the arc spectrum of calcium and ascribed by them to the simultaneous excitation of the two outer electrons. Two combination lines between the principal terms were also detected.

W. V. M.

382. *Regularities in the Spectrum of Ionised Silver.* **C. S. Beals.** (Phil. Mag. 2. pp. 770–778, Oct., 1926.)—The results of an investigation of the first spark spectrum of silver, including the separation of AgII lines from arc lines are described. Lines corresponding to higher ionisations, Zeeman effects, and the numerical relations which have been found to exist in the AgII spectrum included in the paper are discussed. A number of constant differences are found. The terms of AgII have not been definitely identified, but suggestions are made from a comparison of the spectra of palladium.

W. V. M.

383. *Determination of the Refractive Index of X-Rays from the Phenomenon of Total Reflection.* **W. Linnik** and **W. Laschkarew.** (Zeits. f. Physik, 38. 9–10. pp. 659–671, 1926.)—The reflection of X-rays at very small glancing angles from polished plates has been observed by Compton [Abstract 2198 (1923)]. Compton found that the intensity of reflection falls off abruptly when the glancing angle exceeds a certain small value dependent on the substance and the wave-length of the rays, and concluded that the limiting angle is that of total reflection. Putting $\alpha =$ glancing angle, we have $\cos\alpha = \mu = 1 - \delta$, and, since α is very small ($< 1°$), $\delta = \alpha^2/2$. Larsson, Siegbahn and Walter have obtained X-ray refraction in prisms, and Davis and Slack [Abstract 1047 (1926)] have extended the method. Larsson [Abstract 1367 (1926)] has deduced the refractive index from the deviations from Bragg's law. The authors have carried out measurements of total reflection with an instrument capable of precision, called an X-ray total reflectometer. The preliminary investigations were carried out visually, the plate being put on the table of a spectrometer and a fluorescent screen on the telescope whose objective was removed. If a photographic plate is used instead of the screen, a band is obtained from the width of which the limiting angle can be determined. A few results are given for Cu radiation with glass, alum, steel, mica and quartz, but, owing to systematic errors inherent in the method, a more precise arrangement is used. For this the X-ray bundle goes through a slit formed by the plate face and a knife-edge close to the plate. The plate and knife-edge could be rotated exactly 180 degrees, and the distance between the edges of the beam recorded on a photographic plate gave a very exact value for α. The precautions for precision are given, and it is considered that the results are not in error by more than 2″. Polished plates of quartz, calcspar, crown glass, flint glass, and steel were used. Results are included for α and δ. Regular reflection was also obtained at angles exceeding α. From a silvered surface reflection was obtained up to a glancing angle of 2 degrees. J. E.

384. *Energy of X-Rays.* **H. M. Terrill.** (Phys. Rev. 28. pp. 438–443, Sept., 1926.)—An apparatus is described to determine the total energy of X-rays from a tube by the conversion of this energy into heat. The X-rays are absorbed in a lead coil connected with a resistance thermometer bridge, and the amount of heat developed is determined from the current that must be passed through the coil to give the same temperature-rise. The energy thus found is compared with the power input to determine the efficiency of the production of X-rays. A tungsten target tube is excited by constant potential direct current at from 30 to 100 kV, and the energy per unit solid angle is found to be 39 to 305 × 10^{-6} times the power supplied. This corresponds to an approximate total output of the tube of 0·00025 to 0·000192 times the input for the same range of voltages. Plotted against the square of the voltage these values give a straight line to 69·3 kV, where a change of slope occurs, probably due to the selective absorption of the target itself. AUTHOR.

385. *Theory of the Continuous X-Ray Spectrum.* **M. Neunhöffer.** (Ann. d. Physik, 81. 5. pp. 493–522, Oct. 18, 1926.)—An attempt to calculate the energy distribution in the continuous X-ray spectrum, taking into account the possible hyperbolic paths of the electrons in the vicinity of the nuclei of the bombarded atoms. The degree of polarisation is also discussed. The experimental data are in moderate agreement with the theory, but several difficulties arise. W. V. M.

386. *Scattered X-Rays. The J Phenomenon. Part IV.* **C. G. Barkla** and **S. R. Khastgir.** (Phil. Mag. 2. pp. 642–656, Sept., 1926.)—A continuation of previous papers [see Abstracts 553 and 1364 (1926)]. The main experimental conclusions are: (1) When a heterogeneous X-radiation is scattered, the scattered radiation has either precisely the same absorbability as the primary or there is a well-marked difference between the absorbabilities when measured in any one substance. (2) When the scattered radiation is different from the primary when measured in certain substances, its absorbability may be, and frequently is, precisely like that of the primary when measured in certain other substances. (3) Even after transmission through substances which show the difference between primary and secondary radiations, there is still no difference between the two when measured in certain other substances. (4) When the scattered radiation is observed in different directions making angles of 30°, 60°, 90° with the primary beam, and when these radiations differ from the primary in their absorbability in a certain substance, they, in general, differ by precisely the same amount. When a difference appears with increasing angle of scattering, it takes place abruptly—by a jump.

These facts are all explained in terms of a J phenomenon, and no indication of Compton's wave-length change by scattering is observed. It is suggested that the ionisation produced by a beam of X-rays is not dependent on (1) single wave-length and intensity (classical theory), (2) or independent quanta and the number of these (quantum theory), or (3) any combination of these, but, in part at least, upon a quality of the full stream of radiation more closely allied to temperature. This is the meaning of the J phenomenon. W. V. M.

387. *The Scattering Power of Oxygen and Iron for X-Rays.* **A. A. Claassen.** (Phys. Soc., Proc. 38. pp. 482–487, Aug., 1926.)—The present paper describes the results of the quantitative measurement of the intensity of X-ray reflection from different planes of Fe_3O_4. The side of the unit cell = 8·400 Å. The parameter fixing the position of the oxygen atoms has been determined as $x = 0{\cdot}379 \pm 0{\cdot}001$. F curves, representing the dependence of the scattering power of oxygen- and iron-ions on the glancing angle, have been obtained. These F curves (uncorrected for heat motion) decline much more strongly than the calculated curve for Stoner's distribution of electrons amongst atomic levels. AUTHOR.

388. *Theory of X-Ray Scattering. Part II.* **O. Halpern.** (Zeits. f. Physik, 38. 1–2. pp. 149–156, 1926.)—The present paper is a continuation of previous work [see Abstract 1115 (1925)]. Considering the action of a plane linearly polarised sine wave acting on an electron initially at rest, two cases are considered according as to whether radiation damping is taken into account or neglected. In the first case the electron acquires a velocity in the direction of the radiation proportional to the time. This "classical" behaviour of the electron agrees partially with the quantum result, the weak point of the analogy lying in the fact that according to classical theory the electron should radiate with a frequency continuously variable with the time. Other similar points are discussed mathematically. W. V. M.

389. *Immersion of Metals in Homogeneous Media Opaque to X-Rays.* **H. Pilon** and **A. Laborde.** (Comptes Rendus, 183. pp. 658–659, Oct. 18, 1926.)—The use of liquids for the immersion of metallic castings in X-ray examination is recommended in order that the absorption of all parts may be brought within the latitude of the photographic emulsion. The following solutions are recommended: barium chloride for aluminium, barium iodide or lead chlorate for iron, and barium iodide for copper. F. S.

390. *A New Metal X-Ray Tube.* **H. Ott.** (Phys. Zeits. 27. pp. 598–599, Sept. 15, 1926.)—Describes a metal and glass X-ray tube of the Siegbahn type, but with the additional advantage that the components, as filament, target, etc., can be exchanged rapidly without the necessity of cementing operations owing to a patented high vacuum joint of Selmayr. The description is illustrated. B. J. L.

391. *X-Ray Tube with Detachable Electrodes Suitable for Crystal Analysis.* **E. A. Owen** and **G. D. Preston.** (Journ. Sci. Instruments, 4. pp. 1–3, Oct., 1926.)—A porcelain and metal X-ray tube is described which is modified from the well-known Shearer metal and glass X-ray tube. The sealing-wax joints of the Shearer tube are replaced by rubber joints, and modifications are made to the electrodes. The radiation is emitted *via* an aluminium window of foil 0·001 in thickness. Dimensional diagrams of this new design of tube and of a tube support are given. B. J. L.

392. *Method of Studying the Behaviour of X-Ray Tubes.* **R. C. Richards.** (Roy. Soc., Proc. 112. pp. 280–288, Aug. 3, 1926.)—The method suggested for studying quantitatively the radiation output from an X-ray tube in relation to the voltage applied and current flowing employs a system consisting of a 10-in. induction coil, a rotary jet mercury interruptor, and an ordinary Coolidge tube. The interruptor "makes" and "breaks," producing voltages in the secondary of the coil, the latter of these causing a current to flow in the tube, and thus an output of radiation. This cycle is repeated over and over with reasonable constancy if the break is clean and smoothly operated. The method consists in selecting a particular value of t and, for a large number of successive cycles, examining the corresponding instantaneous values of tube current (C), secondary voltage (V) and X-ray output (I). By altering the selected value of t, the variables may be measured again, and so on over the whole series of values of t comprised in a complete discharge. The preliminary results obtained show that little if any difference of phase exists between the variables C, V and I, but it is possible that the inductance and capacity effects balance one another. The ionisation output is concentrated in a narrow region coinciding with the current and potential maximum.

T. H. P.

RADIOACTIVITY.

393. *The Measurement of Low Grade Radium Preparations.* **A. F. Dutton.** (Brit. J. of Radiology, 22. pp. 157–159, Oct., 1926.)—Von Schweidler has expressed the ratio of the observed intensity of a low grade radium preparation in the form of a mathematical series. The author develops on mathematical grounds a more convenient approximate formula. B. J. L.

394. *Irregular Changes of Intensity of Cosmic Radiation at Small Heights above the Sea.* **L. Myssowsky** and **L. Tuwim.** (Zeits. f. Physik, 39. 2–3. pp. 146–150, 1926.)—Simpson and Wright had noted in 1910 a weak increase of cosmic radiation for lower atmospheric pressures. The authors tested the effect by taking measurements with a Kolhörster electroscope sunk to a depth of 102 cm. in a branch of the River Neva, Leningrad, where the river bed was 4·7 m. deep. The apparatus has been described in an earlier paper [Abstract 1850 (1926)]. Corresponding atmospheric pressure and radiation intensity measurements were obtained. The curve connecting mean pressure and current strength was a straight line, and it was found that the change of intensity of radiation for 1 mm.

change of pressure is 0·7 %, a result of the same order of magnitude as the calculated value. A comparison of calculated values with those obtained experimentally shows that the observed oscillation of the intensity of cosmic radiation can be explained by changes of absorption of cosmic radiation in the atmosphere under oscillations of pressure.

R. S. R.

395. *Collision of α-Particles with Helium Atoms.* **S. Ghosh.** (Calcutta Math. Soc., Bull. 17. pp. 99–104, June and Sept., 1926.)—Wilson cloud photographs of 1203 α-particle tracks in helium have been obtained, of which 44 were forked, or 3·65 %; this is rather high compared with that observed in hydrogen. The range of the recoil atoms varies from 0·94 cm. to 3·2 cm., higher than for hydrogen. The angle between the tracks of the recoil atoms and α-particles varies approximately from 1° 23′ to 6° 17′. Darwin's theory predicts in addition to small angles of forking angles of about 90°; no such cases were observed. From this the author concludes that the shape of the He nucleus is oblate spheroidal. None of the recoil atom tracks was appreciably longer than those of the α-particles from which they originated; this shows that the recoil atoms do not exist as singly charged particles during the whole course of their existence as ionising agents.

H. N. A.

396. *Luminescence of Pure Barium Bromide under the Action of α-, β- and γ-Rays.* **L. E. Smith.** (Phys. Rev. 28. pp. 431–438, Sept., 1926.)—The luminescent material studied (chemically pure barium bromide heat treated) is not luminous by itself, nor is the exciting agent (radium sulphate covered with varnish) self-luminous under the existing conditions. By the use of an especially designed brass capsule the barium bromide was held within the range of action of the α-, β- and γ-rays from the radium, but the luminescent material and the exciting agent were kept separate. Under these conditions there was for a time a definite increase in brightness; then from maximum brightness the luminescence decayed with time until a limiting value was reached. Samples of barium bromide from three manufacturers were studied, each under the action of four different amounts of radium. The results were consistent. It was found that the initial luminosity varies with the temperature at which the barium bromide has been treated previous to the action of the rays. The sample was heated to the desired temperature, then cooled quickly to room-temperature, pulverised, placed in the capsule in contact with the radioactive preparation, and the brightness measured as soon as possible. The luminosity gradually increased with the temperature of the heat treatment to a maximum value; then the luminescence decreased and rose again to a second maximum, which was followed by a gradual decrease with further increase in the temperature of the heat treatment through the melting point of the barium bromide.

AUTHOR.

HEAT.

397. *Thermal Conductivity of Li and Na by a Modification of the Forbes Bar Method.* **C. C. Bidwell.** (Phys. Rev. 28. pp. 584–597, Sept., 1926.)—The bar method of Forbes was modified as follows: The metal rod, centred in a large test tube, was placed in a constant temperature bath and heated by a coil at the upper end. Convection in the tube was stopped by cardboard discs through which the rod was threaded and which were spaced at short intervals along the rod. Temperature gradient was determined by thermojunctions spaced along the rod. Cooling curves were obtained on smaller lengths of the rod similarly mounted. With mean temperature not exceeding 15° above bath temperature accurate values of k were obtained. Lithium shows a linear increase in k from 0·15 at 0° C. to 0·20 at − 200° C., thereafter rising sharply to 1·00 at − 246° C. Above 0° C. a minimum occurs at + 40° C. and an increase thereafter to 0·17 at + 140° C. Sodium shows a linear increase from 0·28 at − 40° C. to 0·40 at − 240° C. Above − 40° C. an increase occurs to 0·34 at 0° C. and thereafter a decrease to 0·28 at + 65° C. The breaks in these lines correspond to breaks previously reported in electrical resistance and thermoelectric power lines for these metals. To test the Wiedemann-Franz-Lorentz law the resistances of wires of lithium and sodium were measured at temperatures of ice, liquid oxygen and liquid hydrogen. The "constant" $k/\sigma T$ of the Wiedemann-Franz law was found to have at the higher temperatures the value predicted by the Lorentz theory, and to diminish steadily with temperature in accord with more modern theory. The specific heats of Li and Na were calculated by a comparison of cooling curves. The values found are in agreement with the best previous measurements and are extended to liquid hydrogen temperatures. At the higher temperatures the atomic heats of both metals exceed the Dulong and Petit maximum. It is suggested that this excess is latent heat of crystallisation. At the lower temperatures the results do not show agreement with the Debye specific heat equation.

AUTHOR.

398. *Specific Heats of Tungsten, Boron, Boron Nitride and Beryllium Oxide.* **A. Magnus** and **H. Danz.** (Ann. d. Physik, 81. 4. pp. 407–424, Oct. 8, 1926.)—Using a modified form of the calorimeter previously described [Abstract 1417 (1923)], values of atomic and molecular heats are found as under :—

Material.	Temperature Range, °C.	C_p.
Tungsten	400–900	$6{\cdot}7807 + 0{\cdot}0010475t$
Boron	100–900	$2{\cdot}3658 + 7{\cdot}9080 \times 10^{-3}t$ $- 4{\cdot}9023 \times 10^{-6}t^2$
Boron Nitride	399–900	$2{\cdot}5153 + 6{\cdot}3096 \times 10^{-3}(t - 22)$ $- 3{\cdot}2885 \times 10^{-6}(t-22)^2$
Beryllium Oxide	100–900	$3{\cdot}0890 + 7{\cdot}4640 \times 10^{-3}t$ $- 4{\cdot}7859 \times 10^{-6}t^2$

For tungsten calculations of C_v are made after Grüneisen's equation, and the values found are considerably in excess of $3R = 5 \cdot 955$. For boron and boron nitride the most probable course of C_v is found by the application of the Debye equation. G. A. S.

399. *Thermal Expansion of Copper at Low Temperatures.* **W. H. Keesom, F. P. G. A. J. van Agt** and **(Miss) A. F. J. Jansen.** (K. Akad. Amsterdam, Proc. 29. 6. pp. 786–791, 1926.)—The thermal expansion at low temperatures of electrolytic copper was measured, using the methods devised by K. Onnes [see Abstract 783 (1926)]. The following mean expansion coefficients $\times 10^6$ were obtained: between 0° and − 100° C., 15·36; 0° and − 180° C., 14·01; − 100° and − 180° C., 12·35; − 180° and − 250° C., 5·45. The first three figures agree closely with previously published results, and the last is a new figure. C. O. B.

400. *Latent Heats of Fusion of Some Metals.* **J. H. Awbery** and **E. Griffiths.** (Phys. Soc., Proc. 38. pp. 378–398, Aug., 1926.)—The latent heats of a number of the commoner metals have been measured by determining the total heat of liquid and solid from a series of initial high temperatures. The calorimetry was by the method of mixtures, introducing several refinements, of which the chief were the use of fairly large charges of metal (of the order of 2 kg.), and a device by which the hot charge was not allowed in contact with the water of the calorimeter until the latter was completely closed; this eliminates error due to production and escape of steam, with a consequent loss of heat. The device referred to consisted in the provision of a sheet metal vessel suspended by threads from the main lid of the calorimeter. The aperture through which the charge was introduced was closed by a rotating lid, in the main lid, and the crucible being introduced, was submerged after the closing of this smaller lid by means of a wire passing through an eyelet in the base of the calorimeter and out at the top.

The results for the latent heat are given below :—

Metal.	Melting Point, °C.	Latent Heat (Calories per gm.).
Aluminium	657	92·4
Antimony	630	24·3
Bismuth	269	13·0
Lead	327	$6 \cdot 2_6$
Magnesium	644	46·5
Tin	232	14·6
Zinc	420	26·6

The paper also contains values for the specific heats up to the melting point, obtained by the differentiation of the curves of temperature and total heat. AUTHORS.

401. *Space Diagram of the Three-Component System $NaOH–NaCl–H_2O$.* **A. v. Antropoff** and **W. Sommer.** (Zeits. phys. Chem. 123. pp. 161–198, Sept. 15, 1926.)—An apparatus is described which admits of the thermal analysis of binary and ternary systems comprising a volatile component at high temperatures and under atmospheric pressure. Corrected and extended results are given for the two binary systems NaCl–NaOH and NaOH–H_2O. The "second boiling point" for NaCl–H_2O is found to be 780 ± 5°, the corresponding water content being $0{\cdot}2 \pm 0{\cdot}2$ %. For the ternary system NaCl–NaOH–H_2O results are given for the temperature range 150–800°, and the data necessary for the completion of the fusion diagram deduced. The 1-atmosphere isobars for various compositions are traced between 270° and 800°, and their probable courses to 170° extrapolated. The behaviour of ternary systems with mixed crystals when the components show transformation points is discussed and the course of the isobars in ternary system considered in relation to the second boiling point. T. H. P.

402. *Lattice Dynamics of the Fusion Process.* **W. Braunbek.** (Zeits. f. Physik, 38. 6–7. pp. 549–572, 1926.)—On the assumption that thermal movement in a binary polar crystal may be homogeneous with respect to velocity and phase, and that two rigid lattice parts—*viz.* of the positive and negative ions—oscillate with respect to each other, the author has derived a mechanical picture of the fusion process. This picture sets a series of thermal magnitudes in relation to a rising value A of the potential energy which both lattices must exceed by their mutual displacement. By elimination of A, relations are obtained between different thermal quantities which enable experimental comparison, *viz.*: The proportionality between absolute fusion temperature T_{sm} and heat of fusion (Richard's rule); the deviation of the atom heat C from the value 3R at high temperatures; a relation between dc/dT at high temperatures and T_{sm}; the relation between the melting point and the ultra-red frequency (Lindemann formula). All the constants obtained are correct to a fair approximation. For the absolute determination of A and therewith of the fusion point, the present view and knowledge of atomic forces are insufficient, but it is shown that the actual fusion point is not far from the theoretical values now obtained. From the analytical form of A a relation is derived connecting lattice distance and fusion temperature which is confirmed by experience, and can be included in a satisfactory manner in the periodic system. H. H. Ho.

403. *The Vapour-Pressure Curve of Carbon.* **H. Herbst.** (Zeits. techn. Physik, 7. 9. pp. 467–468, 1926.)—The writer points out the consequences of H. Alterthum's paper [see Abstract 117 (1926)] on the melting and vaporisation of carbon, and draws attention to his own work [see Abstract 2649 (1926)], in which he states that the boiling point of carbon is about 6000° abs. He reiterates the arguments of his previous paper, and gives the temperature of the positive crater of the arc burning freely in air as 4200° abs. S. G. B.

404. *Chemical Constants of the Halogen Hydrides.* **F. I. G. Rawlins.** (Faraday Soc., Trans. 22. pp. 233–240, Sept., 1926.)—On the basis of certain assumptions and without using direct experimental information in molecular heats and heats of transformation at low temperatures, an attempt is made to calculate the chemical constants of the compounds HCl, HBr, and HI from the vapour-pressure equation for the equilibrium $(\text{Halogen hydride})_{\text{diatomic}} \rightleftharpoons (\text{Halogen hydride})_{\text{solid}} + \lambda$. The results obtained differ considerably from those deduced from Ehrenfest's theory

[Abstract 1576 (1921)], but agree well in two cases with Eucken's recent work [Abstract 165 (1925)]. T. H. P.

405. *Temperature and Energy in Gases.* **E. Wertheimer.** (Zeits. f. Physik, 33. 9–10. pp. 675–705, 1926.)—Following up a previous investigation [see Abstract 2124 (1925)], which showed that a gas was always associated with a field of electromagnetic radiation-energy, the author finds that in a gas of specific volume v and at a temperature T the radiation energy, so far as this depends on black boundary walls and the translatory movement of the molecules, is expressible (provided the gas be rarefied) by a formula of the form $u = aT^4 + \phi(v)T$. A. D.

406. *Size Distribution among Gaseous Ions.* **W. Busse.** (Ann. d. Physik, 81. 3. pp. 262–280, Sept. 17, 1926.)—The size of ions varies from that of a molecule up to those of particles of microscopic visibility. Among these certain sizes apparently occur more frequently than others, this being in contradiction to the author's previous results. The effect of grouping, found by Nolan [see Abstract 1259 (1926)], in ions produced by the spraying of water, is explained as due to the self-charging of the sprayer. Ionisation experiments with phosphorus show that a continuous dimension interval preponderates, and the results do not support the views of McClelland and Nolan [see Abstract 452 (1920)]. Uniform distribution of ionic dimensions occurs also when ionisation is produced by means of radioactive material. G. E. A.

407. *Isothermals of Helium, Hydrogen and Neon below* − 200°. **L. Holborn** and **J. Otto.** (Zeits. f. Physik, 38. 4–5. pp. 359–367, 1926.)—This paper gives an account of the extension of the authors' previous work [see Abstract 2549 (1925)]. A new piezometer made from steel tubing was employed, as the previous one, bored from the solid, gave trouble with gas, which penetrated the metal and was released when the pressure was relieved. A diagram is given of the arrangement of the apparatus. The results of the experiments are given in tables; the helium observations extended to − 258° and the hydrogen and neon to − 208°. The constants in the equation $pv = A + Bp + Cp^2 + Dp^3 + Ep^4$ are calculated and tabulated. The correction of the constant volume and constant pressure gas thermometers for the three gases, to bring the readings to the absolute scale, are also tabulated. Finally these corrections are compared with those of K. Onnes and his co-workers, and a satisfactory agreement is found between the Leiden and Reichsanstalt results. T. B.

408. *Alteration of Temperature of Gases during Expansion by Throttling and Performing External Work.* **H. Hausen.** (Zeits. techn. Physik, 7. 8. pp. 371–377, and 7. 9. pp. 444–452, 1926.)—A theoretical discussion of the problem. The Thomson-Joule effect is utilised to furnish values for the calculation of the cooling of air during expansion under conditions of performance of external work. A modification of the law is deduced which will approximately fit both methods of expansion. In order to explain the inner mechanism of the method of expansion, as in the case of air, the individual portions of the temperature alteration due to throttling or due to the performance of external work are assumed to be of equal importance. Throttling creates a cooling, and the alteration of the product pv a warming effect. The heating is usually considerably less than the cooling. In the expansion during the performance of external work the effect of the internal forces increases the higher the pressure and the lower the temperature. Actual figures are given in support of this contention. The formulæ deduced are utilised to give an approximate calculation of the specific heat C_v. S. G. B.

409. *The Problem of Atomic Oscillation Frequencies.* **H. Sirk.** (Zeits. f. Physik, 37. 12. p. 926, 1926.)—This note is in reply to a criticism by Rawlins [see Abstract 1405 (1926)] on the author's criteria for the validity of Grüneisen's theories of solid bodies in particular when applied to those of very low melting point. The experimental data still required are briefly reviewed. H. H. Ho.

410. *Occurrence of Helium in Spa Gas from Daylesford, Victoria.* **G. A. Ampt** and **E. J. Hartung.** (Roy. Soc. Victoria, Proc. 38. pp. 150–154, 1926.)—Spectral examination of the inert gases separated from Daylesford spa gas show that they consist of argon, with some helium and a small proportion of neon. The value of the density, measured by means of an Aston silica density balance, gives the molecular weight as 35·1 and indicates that 100,000 parts of the original spa gas contain 39 parts of argon and 6 parts of helium. T. H. P.

411. *Classical Mechanics and Thermal Radiation.* **Z. Klemensiewicz.** (Zeits. f. Physik, 39. 2–3. pp. 151–152, 1926.)—The applications of classical mechanics and electrodynamics to radiation between reflecting walls by Rayleigh and Jeans on the one hand and by Lorentz on the other are investigated, and, partly in conjunction with Smekal's work, it is shown that these applications cannot be given as a proof that the classical theory fails when only pure radiation without matter comes into consideration. H. H. Ho.

412. *Maxwell's Law and the Absorption and Emission of Radiation.* **E. A. Milne.** (Cambridge Phil. Soc., Proc. 23. pp. 465–471, Oct., 1926.)—In the famous paper [see Abstract 654 (1917)] in which he developed his theory of radiation, Einstein investigated two problems: (1) The problem of what distribution of radiant energy the steady state would be set up by an enclosed assembly of atoms in thermodynamic equilibrium radiating and absorbing according to the assumptions of his theory; he showed that the distribution so set up was given by Planck's law. (2) The velocities set up amongst the atoms in consequence of the random variations in direction of the emissions and absorptions; provided that emissions are assumed to be directed, so giving rise to recoil momentum, he showed that the mean square velocity-component in a given direction, $\bar{v}^2$, is equal to its equipartition value, given by $\frac{1}{2}m\bar{v}^2 = \frac{1}{2}kT$. He did not, however, show that the velocity-distribution set up was Maxwellian. In view of other applications of Einstein's methods, the author completes the investigation. Einstein's applications are both applicable only when the system is an enclosed one in thermodynamic equilibrium. The author's generalisation is freed from this. It can be used in cases where there is a steady state which is not a state of thermodynamic equilibrium. Cases of this type occur frequently in the problems presented by astrophysics. G. W. de T.

SOUND.

413. *Acoustic Pressures for Soap Bubbles.* **C. Barus.** (Nat. Acad. Sci., Proc. 12. pp. 480–482, Aug., 1926.)—The telephonic apparatus and pinhole probe described in previous papers is here used to study the influence of yielding walls on the acoustic pressure, and the results are given graphically. W. H. Ge.

414. *Acoustic Pressure Promoted by Cooperating Quill Tubes without Pinholes.* **C. Barus.** (Nat. Acad. Sci., Proc. 12. pp. 482–486, Aug., 1926.)—A note dealing with details connected with modifications of pinhole probes. The effects of various changes are shown in experimental graphs. W. H. Ge.

415. *Impact of Elastic Hammer on Pianoforte String.* **P. Das.** (Indian Assoc. for Cultivation of Science, Proc. 10. pp. 75–96, Aug., 1926.)—Following on a previous paper [see Abstract 2421 (1926)], an experiment was made in order to decide whether the law of Hooke or that of Hertz is correct in the case of the pianoforte. A pianoforte hammer, its hinged end fixed in a clamp, was mounted on a rigid block and loaded by a scale pan hung from a point on the arm of the hammer with weights ranging from 100 to 1500 gm. The compression of the felt was measured by means of a travelling microscope by observing the displacement of the point of a pin stuck into the core of the hammer. The curve of load against compression was found to be roughly a straight line passing through the origin pointing to Hooke's law. Kaufmann's treatment of the problem (Ann. d. Physik, 58. p. 678, 1895) is here extended to the case of the elastic hammer and his formula shown to be a special case of the author's formula. As the equation having the duration of impact for a root cannot in general be solved algebraically, a graph of duration of impact against striking length (the part of the string lying between the hammer and the near end) has been drawn. The treatment is entirely mathematical. E. F.

416. *The Condenser Telephone.* **G. Green.** (Phil. Mag. 2. pp. 497–508, Sept., 1926.)—A theoretical treatment is given relative to the properties of the condenser telephone. It would appear that such telephones, when properly designed, reproduce vibrations delivered to them uniformly and equally over a wide range of frequency. On the other hand, condenser telephones of low capacity show decided resonance effects. Some of the formulæ derived have been generally verified for a considerable range of values of capacity and of voltage, but the experimental verification is still incomplete. The high quality of the reproduction of speech and music by the condenser telephone has been amply demonstrated by experiments now in progress and of which an account will be given later. A. W.

417. *Damped Hertzian Vibrators.* **W. Arkadiew** and **A. Leontiewa.** (Zeits. f. Physik, 33. 9–10. pp. 706–715, 1926.)—Interference experiments with large path-differences show that besides the strongly damped fundamental, vibrations there are also extremely weakly damped overtones. A. D.

418. *"Boys" Type of Double Resonator.* **E. T. Paris.** (Phil. Mag. 2. pp. 751–769, Oct., 1926.)—Extends the theory developed in previous papers to take into account loss of sound-energy from the resonator owing to (1) dissipation of sound into heat by viscous forces in the narrow neck leading into the Helmholtz resonator, and (2) escape of sound into the surrounding air through the open end of the pipe component. Some numerical results given show the changes indicated by theory in the form of the resonance curves caused by (*a*) diminishing the cross-sectional area of the pipe, and (*b*) moving the Helmholtz resonator from the closed towards the open end of the pipe. The forms of the calculated resonance curves are in fair agreement with observations, and the resonance frequencies predicted by the present theory agree well with those found from the previous approximate theory. W. H. GE.

419. *Sound Absorption by Resonators.* **P. N. Belikov.** (Zeits. f. Physik, 39. 2–3. pp. 233–240, 1926.)—A cubical lattice of closed cylindrical resonators, with their open ends turned towards the source of sound, is placed between two paraboloidal reflectors, at the foci of which are similar telephones, one acting as transmitter and the other as receiver. The existence of an absorption region dependent on the natural frequency of the resonator and the "period" of the lattice is demonstrated. As theory predicts, the position of this region is displaced in the direction of waves shorter than the natural wave-lengths of the resonators. With an increase of the period of the lattice a displacement of the maxima of absorption towards the direction of increased wave-lengths is observed, as well as a narrowing of the absorption band. G. A. S.

420. *Wave Propagation in the Atmosphere.* **H. Galbrun.** (Comptes Rendus, 183. pp. 652–653, Oct. 18, 1926.)—A note discussing wave propagation in the atmosphere from a point of view somewhat different from that adopted by M. Esclangon in *L'Acoustique des Canons et des Projectiles*, but leading to the same results. W. H. GE.

421. *Amplitude of Sound Waves in Pipes.* **E. G. Richardson.** (Roy. Soc., Proc. 112. pp. 522–541, Oct., 1926.)—The amplitudes were tested within a stopped organ pipe of pine with a frequency of 105, when blown under a pressure of 1·8 in. of water. The amplitude is deduced from the velocity, measured by means of a hot-wire grid calibrated in a steady draught at speeds up to 500 cm./sec. The mode of variation of the velocity along the pipe depends on the pressure employed; at a pressure of 5 in. both the fundamental and the second harmonic were sounding well; at 10 in. only the latter could be heard. The grid method was also adapted to the measurements of the decay of sound in narrow tubes (1·7 mm. diam.) and of the absorption coefficients of materials. Some values of the latter are given for hair felt, asbestos, cork, cabot quilt and carpet. [See also Abstract 1659 (1923)]. G.E.A.

422. *Passage of High-Frequency Sound through a Liquid.* **R. W. Boyle** and **J. F. Lehmann.** (Roy. Soc. Canada, Trans. 19. Sect. 3. pp. 159–165, 1925).—Describes a method making use of dust figures for demonstrating the interference of two or more trains of longitudinal waves (frequency 96,000 per sec.) passing through a liquid, and of measuring their velocity. G. A. S.

423. *Diffraction of High-Frequency Longitudinal Waves in a Liquid.* **R. W. Boyle, J. F. Lehmann** and **C. D. Reid.** (Roy. Soc. Canada, Trans. 19. Sect. 3. pp. 167–196, 1925).—Using a torsion pendulum as a probe, measurements are made of the energy in different parts of a diffracted beam obtained by setting the parallel faces of a circular plate of suitable size in vibration perpendicular to their planes. A dust-figure method of demonstrating the formation of diffracted beams is also described. The effect of obliquity, which is negligible in the case of light, is here considered. Similar measurements and demonstrations are carried out for beams reflected from various reflectors. G. A. S.

424. *Vocal and Instrumental Tones.* **C. Stumpf.** (Zeits. f. Physik, 38. 9–10. pp. 745–758, 1926.)—According to Helmholtz, vowels are produced by the strengthening of certain harmonics of the vocal ligaments by means of the mouth cavity. These characteristic tones have for each vowel a fixed pitch independent of the pitch of the fundamental. The author's researches confirm Helmholtz's views. Experiments were made to determine the constituents of vowel sounds by (1) the resonance of tuning forks, (2) the exclusion of each partial through interference, and (3) synthesis of the sound from its components. The range of partials which contribute in forming a vowel sound is wide, and their relative strengths are given up to the sixteenth. The fundamental is not necessarily the loudest partial; its strength diminishes from U (oo) through O (oh) to A (ah) and then increases from A through E (ay) to I (ee). Also, only harmonic partials are present. The interference method employed was that of Grützner. Nine systems of pipes, containing in all 71 side-tubes, were available which were capable of extinguishing all tones from C♯ (70) upwards by the motion of a piston in the side-tube. From the tabulated observations it was found that the fundamental c' (256) gave by itself the vowel U, the first and second partials the sound O. The vowels ö, ä, ü, e, i have more constituent tones than u, o, a; the upper maxima in the latter vowel sounds play no part except in giving tone-quality, but they are necessary to give the true vowel sounds in the case of the other vowels. The synthetic method made use of twenty-eight pipes which had been freed from their overtones by means of interference tubes. Recognition of the vowels was attained by impartial listeners in a neighbouring room. A high order partial may be replaced by an unharmonic substitute without spoiling the synthetic effect, but change of the lower partials injures both the musical and the vowel character of the sound. The above methods were also employed to analyse or synthesise the tones of the tenor trombone, B-trumpet, B-clarinet, double bassoon, and bassoon, and the partials of horns in c, c' and c^2 are given. [See also Abstracts 783 (1918), 1294 (1921) and 173 (1922).] G. E. A.

425. *Sound Pulse Photography as applied to the Study of Architectural Acoustics.* **A. H. Davis** and **N. Fleming.** (Journ. Sci. Instruments, 3. pp. 393–398, Sept., 1926.)—The paper describes in detail the apparatus and technique at present employed at the National Physical Laboratory for sound pulse photography in connection with the study of the reflecting characteristics of model sections of auditoriums. Examples of photographs are given. AUTHORS.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

426. *Mechanics of the Electric Field.* (*The Seventeenth Kelvin Lecture.*) **J. J. Thomson.** (Inst. El. Eng. J. 64. pp. 721–726, July, 1926. Electrician, 96. pp. 493 and 502, April 30, 1926. Abstract. Engineering, 121. pp. 579–580, May 21, 1926. Nature, 118. pp. 342–345, Sept. 4, 1926.)—Are Maxwell's equations as fundamental as has been assumed, or do they do no more than give relations between average values of the quantities defining the field? Assuming light to be electrical, there can be no unlimited propagation of spherical electric waves diverging from a source, for on this view light energy is distributed continuously through space and the energy per unit volume diminishes indefinitely as the light travels from the source. But the condition for the propagation of a periodic disturbance is that its period should be greater than the time interval of the electric field; this interval increases as the energy in the light diminishes, so that when the energy falls below a certain value, which is small for long period vibrations and large for short period ones, further propagation is impossible. Thus the intermittence of electrical force demands a theory where the energy is done up in bundles which do not alter in size as they travel through space. The bundle may consist of a distribution of electric force, like a piece cut out of what on the classical theory represents a beam of light. This piece is prevented from spreading because the energy density at its boundary has the critical value, and this boundary acts, on our view, like a reflecting surface, and sends back any disturbance which tries to get outside it. These units are pictured as consisting of two parts: a central core in the form of an anchor ring, the plane of the ring being at right angles to the direction in which the unit is travelling. This ring is the seat of an intense electric field, and the circumference of the ring is equal to the wavelength of the light. The ring corresponds to the quantum of the light. This ring vibrates and emits electric waves which, after travelling to a certain distance from the centre, reach the limit where the time interval of their electric field is equal to the period of the light. This forms the boundary of the unit, and the space occupied by the waves and the energy in them remain unaltered as the unit travels through space. On this view, light has a dual structure consisting of electrical waves with the quantum as the core. The electrical waves give rise to interference effects, the quanta to photoelectric ones. On the view that the force is intermittent, the electric field must have a structure, and as electrons and positive particles are the centres of intense electric fields, they are probably more complex than the usual conception of them, and must be regarded as centres of complex systems associated with an electron or a positive particle. Comparing the atom with its electrons to a solar system, an electron or a positive particle may be compared to the centre of a nebula and the electron be regarded as surrounded by an atmosphere of small particles. This atmosphere can be distorted by the presence in its neighbourhood of other electrons or positive particles with their atmospheres, and will assume a shape appropriate to its surroundings.

Thus the atmosphere round an electron, far from other charges, would be symmetrical, and, if it were distorted, would vibrate about the symmetrical shape. Thus vibrations could be associated with single electrons or single positively charged particles, even though the electron or particle were itself at rest. The possibility of vibrations of an electric field apart from any movement of the charges in the field does not appear to have been sufficiently realised. G. W. de T.

427. *New Deductions of the Electromagnetic Equations.* **W. F. G. Swann.** (Phys. Rev. 28. pp. 531–544, Sept., 1926.)—Two derivations of the circuital relations are given. First derivation: We assume that there exists a vector E whose divergence $\rho \equiv \operatorname{div} \mathrm{E}$ is conserved in the sense of the equation of continuity $\partial\rho/\partial t + \operatorname{div} \rho u = 0$. We thus find $\operatorname{div} (\rho u + \partial \mathrm{E}/\partial t) = 0$, so that there exists a vector H such that $\rho u + \partial \mathrm{E}/\partial t = c \operatorname{curl} \mathrm{H}$. We complete our specification of H by the assignment of a quantity σ, and define div H as $\operatorname{div} \mathrm{H} \equiv \sigma$. The assumption that σ is conserved in the sense of the equation of continuity leads to the conclusion that there exists a vector ϵ such that $-(\sigma v + \partial \mathrm{H}/\partial t) = c \operatorname{curl} \epsilon$. If we then postulate that the whole system of equations is invariant in form under the Lorentzian transformation, we deduce that $\epsilon = \mathrm{E}$, and the equations assume the classical form generalised by the σ terms. The association of the vectors which appear in the transformed system with those in the untransformed system is discussed, and is shown to require, logically, a specification of the nature of the definition of E. It is shown that if E be defined in terms of the motion produced in an electron, the rigorous establishment of the correspondence necessitates the assumption of a suitable equation of motion.

Second derivation: We assume an equation of electronic motion of the form $\mathrm{E} + [w\mathrm{H}]/c = \mathrm{P}$, where P is a function of the motion of the electron such that $k\mathrm{P}$, $ki(\mathrm{P} . w)/c$ is a 4-vector, and $k = (1 - w^2/c^2)^{-\frac{1}{2}}$, and where E is defined as the limit of P when w is zero, and H is defined in terms of the limiting ratio of the absolute magnitude of $\mathrm{P} - \mathrm{E}$ to the absolute magnitude of w. The assumption of the invariance of this equation for a transformation from a system S to a system S′ leads to a relation between the fields in the two systems. ρ and σ are defined as div E and div H respectively, and it is assumed that, $d\tau$ being an element of volume, $\rho d\tau$ is invariant and $\sigma d\tau$ is invariant. It is then shown that the invariance of $\rho \equiv \operatorname{div} \mathrm{E}$ and $\sigma \equiv \operatorname{div} \mathrm{H}$ necessitate respectively, $\frac{1}{c}(\rho u + \partial \mathrm{E}/\partial t) = \operatorname{curl} \mathrm{H}$ and $-\frac{1}{c}(\sigma v + \partial \mathrm{H}/\partial t) = \operatorname{curl} \mathrm{E}$. Author.

428. *Significance of Vectorial Operators and Maxwell's Equations.* **C. Rimini.** (Elettrotecnica, 13. pp. 665–672, Oct. 15, 1926.)—Many of the more delicate problems of modern electrotechnics necessitate recourse to Maxwell's fundamental equations of the electromagnetic field and to their consequent calculation developments, these in their turn being based on the fundamental properties of vectorial fields. The object of the paper, which is mathematical throughout, is to call attention to the practical significance of symbols which are to be considered not as mere abstractions, but as the mathematical expression of essentially physical conceptions. E. F.

429. *Theory of the Deformable Magnetic Circuit.* **A. Guilbert.** (Rev. Gén. d'Él. 20. pp. 581–595, Oct. 23, 1926.)—This theory and the determination of the formula of its attraction have hitherto been founded entirely upon theoretical and mathematical considerations, no experiments having yet been devised to test them adequately. This theory does appear satisfactory in the case of a magnetic circuit free from leakage, but breaks down in the presence of leakage, especially in the distribution of the leakage. And the hypotheses suggested for its determination lead to conclusions widely differing from the facts. In the present paper the author takes as his starting point the theory of the functioning of the electromagnet with a deformable armature; his experiments, discussed at length, have enabled him to verify some of the hypotheses of the deformable theory and to modify others. G. W. de T.

430. *Conformal Representation and Electrotechnics.* **E. Weber.** (Archiv f. Elektrot. 17. pp. 174–200, Oct. 9, 1926. **Errata** (*ibid.*, p. 354, Oct. 25, 1926).)—An introduction to the methods of conformal transformation. Schwarz's theorem and its applications. Examples are given of the utility of the method in solving problems in electrotechnics. G. A. S.

431. *Sub-Electrons.* **E. Regener.** (Zeits. f. Physik, 39. 4. pp. 247–250, 1926.)—Discussing the work of Durau [see Abstract 2467 (1926)] on absorption of gases by glass and silver powders and its relation to the author's theory [see Abstract 907 (1921)], it is pointed out that the recent results obtained by Sanzenbacher [see next Abstract] permit a satisfactory explanation to be given of the apparent discrepancies between theory and Durau's results. The disturbing effect originates in every case from the surface of the particles. A. W.

432. *Electric Charges on Vaporised Particles.* **R. Sanzenbacher.** (Zeits. f. Physik, 39. 4. pp. 251–275, 1926.)—A comprehensive series of measurements of the electric charge carried by mercury particles was made under various conditions in the three gases, air, hydrogen and CO_2. The results obtained show that mercury particles which are subjected to a relatively rapid vaporisation or condensation give normal values for the electric charge in CO_2 and in air both when the radius of the particles is less than 10^{-5} cm. and in the region in which as a rule sub-electrons are produced. In hydrogen normal charges were in general only found with particles subjected to strong vaporisation. Apparent variations of the elemental charge were obtained with mercury particles whose vaporisation was hindered. The bearing of these results on Regener's theories [see Abstract 907 (1921)] is discussed. [See also preceding Abstract.] A. W.

433. *Two-Dimensional Fields specified by Elliptic Functions.* **W. B. Morton.** (Phil. Mag. 2. pp. 827–833, Oct., 1926.)—A note extending J. J. Thomson's treatment of electric fields specified by elliptic functions. Drawings are given for a number of cases, and expressions are found for the capacity and distribution of the charge in the case of a condenser formed by two parallel strips. G. A. S.

434. *Characteristics of Electrostatic Machines.* **E. J. Evans.** (Phys. Soc., Proc. 38. pp. 459–468; Disc., 468–469, Aug., 1926.)—Experiments are described in which a large electrostatic machine is used as a source of potential for the discharge through (*a*) a Coolidge X-ray tube and (*b*) a non-inductive resistance. The results are represented in the form of characteristic curves. In the former case it is shown that above a certain critical voltage the discharge is intermittent, while in the latter case the discharge is continuous for all voltages. The cause of the intermittence of the current through the Coolidge tube is assigned to the operation of the Pearson-Anson effect, and this implies the conclusion that the effect of the residual gas in such tubes is not completely insensible above a certain voltage. AUTHOR.

435. *Theory of Wimshurst's Alternating Static Machine.* **A. W. Simon.** (Phys. Rev. 28. pp. 545–553, Sept., 1926.)—The quantitative theory of Wimshurst's alternating static machine is developed in detail according to the general method previously given by the author for other static machines. The theory predicts that the potential of any element of the machine will reverse at definite intervals and at the same time increase in value. While the exact period of reversal depends on the capacities involved in the machine, the approximate period can be calculated and is found to be the time of one revolution rather than the time of three-quarters of a revolution as observed by Wimshurst. An actual machine was constructed and the reversal observed by means of the glow in discharge-tubes. It was found that such a machine does reverse every revolution rather than every three-quarters of a revolution. The theory given can be extended to other machines of the same type with more than four inductors. The period of reversal of a six-inductor machine is calculated to be approximately the same as that of a four-inductor machine. AUTHOR.

436. *Stormy Oscillations of the Electric Field and their Propagation to a Great Distance. Application of the Amplifying Electrometer.* **P. Lejay.** (Onde Élec. 5. pp. 493–531, Oct., and pp. 557–576, Nov., 1926.)—Observations were made at the Pic du Midi Observatory on the atmospheric electric field and variations produced in it by electric storms or atmospherics, the observatory possessing several advantages of site for this purpose. Full details are given of the method and the apparatus employed, and mathematical expressions deduced for the field produced by a rectilinear discharge between clouds or between a cloud and the ground. The different effects produced on an antenna and a frame aerial are investigated. An analysis of the observations due to storms seen from the observatory in the summer of 1925 showed that static field changes of 300 volts/m. could occur at a distance of 30 km., and of some tenths of a volt/m. at 100 km. This showed that the discharge coincides with the atmospherics received on antennæ, but numerous variations in the field occur with no luminous manifestation. The author considers that the usual mounting with the kathode oscillograph distorts the atmospherics. Meteorological considerations confirm these results in a way, while the atmospherics may themselves be progapated to considerable distances if the discharge giving birth to them were itself violent. R. S. R.

437. *Frequency of Lightning.* **S. Rump.** (Schweiz. Elektrot. Verein. Bull. 17. pp. 407–427, Sept., 1926.)—The results obtained by Norinder on changes in the magnetic field, and by Watson Watt on the duration and path of electric discharges, indicated that the discharge was a relatively slow process. The author considers how quickly the discharge from a thunderstorm cloud must proceed so that in spite of the distribution of the excess voltage through a conducting network the local extension of the region of excess voltage is explainable. Among the several factors examined are the progress of the changes in the field accompanying the discharge and the distribution of these changes in space and their magnitude. The author finds that an aperiodic field change accompanies the lightning discharge which in extreme cases may reach 280 kV/m. and extend over a distance of 5 km., but usually does not exceed 100 kV/m. or extend farther than 2 km. Mathematical relations are established for the excess voltage on conductors and the form of the wave and its variation. Values are tabulated for the frequency of the discharge necessary to produce excess voltages of 110, 50 and 8 kV in a conductor supported on masts 10 m. high for iron and 6 m. high for wood, and having earthed or non-earthed connections. These calculations hold further for transformers and similar machines. Finally, the influence of the lightning frequency on the efficacy of protection from excess voltages is examined. The examples taken are not meant to be complete, but furnish a clue to the possible frequency of lightning. R. S. R.

DISCHARGE AND OSCILLATIONS.

438. *Electric Explosion of Wires and Threads.* **H. Nagaoka, T. Futagami** and **T. Machida.** (Imp. Acad. Tôkyô, Proc. 2. pp. 328–331, July, 1926. In English.)—Wires were exploded by connecting them in circuit with a condenser of capacity 1·7 μfd. which was charged by rectified transformer current to about 40 kV. Photographs of the effects with different wires and moist threads are given in the paper. With long wires of copper, iron, aluminium or manganin similar effects were observed. Beads of light are formed throughout the whole length, but especially near the centre. With long threads, several points were scorched, from which light was emitted. These points were not so numerous as the beads in the wires. Without inductance thread soaked with KNO_3 exploded with violence. When the thread was shortened it exploded in zigzag form. Violent explosions of thick wires about 10 cm. long were often noticed, being stronger at the positive pole than at the negative. When a wire explodes the particles are shot off perpendicular to the direction of the current. A. W.

439. *Absorption of Hydrogen Canal Rays in Hydrogen. Part II.* **R. Conrad.** (Zeits. f. Physik, 38. 6–7. pp. 465–474, 1926.)—In the first part of this paper [see Abstract 816 (1926)] was described an experimental determination of the value of the exponent of the dispersion formula for the case of hydrogen canal rays in hydrogen. A calculation of the exponent is now given. In the calculation it is necessary to take into account the effect of charges and multiple scattering besides the scattering effect of both the nucleus and the electrons of the hydrogen molecule. The value then found approximates to that determined experimentally. A. W.

440. *Kathode Scattering. Part II. Derivation of the Law of Collision Scattering by Means of Silver in Hydrogen.* **A. Güntherschulze.** (Zeits. f. Physik, 38. 8. pp. 575–588, 1926. From the Reichsanstalt.)—The scattering of silver in hydrogen in dependence on the distance of the parallel plane electrodes at 1000-volt kathode fall is investigated. It is found that in the ampere-hour the scattered quantity of silver is exactly inversely proportional to the distance of the electrodes, *i.e.* $Q.c =$ a constant where $Q =$ scattered silver, $c =$ distance of electrodes. By far the greater part of the silver vaporised from the kathode diffuses back again to the kathode. When the kathode is changed to a wire, the diameter of which is comparable with the free path of the diffusing atoms, this can no longer happen. The quantity scattered per ampere-hour increases very much with decreasing diameter of the wire. The dependence of the kathode scattering of silver in hydrogen with kathode fall V shows a direct proportionality between the constants in the formula $Q.c.p =$ constant (where p is the pressure of the hydrogen) and the kathode fall, from which a simple law results $Q_{Ag.H} = C_{Ag.H} V/c.p$. For silver in hydrogen it is found that $C_{Ag.H} = 0{\cdot}868$. Through this law the measurement of kathode scattering is placed on a new basis. As basis for these measurements the value of the scattering in hydrogen of twenty-five metals, and for most in oxygen also, is used. This paper deals with these questions in the following way: Dependence of scattering on distance of electrodes with parallel plane electrodes; dependence of kathode scattering on kathode fall; comparison of scattering of different metals in hydrogen and oxygen. [See also Abstract 2165 (1926).]

A. E. G.

441. *Experiments on the Scattering of Electrons by Ionised Mercury Vapour.* **A. F. Dittmer.** (Phys. Rev. 28. pp. 507–520, Sept., 1926.)—Further experimental studies were made of a phenomenon first described by Langmuir [see Abstract 826 (1926)]. He found that if electrons from a hot filament were projected into an ionised gas with a uniform velocity they did not retain this uniform velocity, but some were retarded and some accelerated as though a random velocity distribution had been impressed upon the uniformally moving stream. The pressure of gas was sufficiently low that only a small percentage of the electrons scattered had collided with gas atoms. Experiments were carried out to determine the exact nature of this scattering and its dependence upon the variables of the tube. The experiments on the variation with distance showed that the scattering all took place within a limited region surrounding the filament, the size of this region being directly proportional to the original velocity of the electrons. With this experimental basis a theory to account for the scattering is indicated. Fluctuations in potential distribution rapid enough to be comparable in period with the time taken by the electrons to pass across the space between the filament and the electrode used to study the velocity distribution are shown to be sufficient to account qualitatively for all the phenomena observed. No direct evidence that these fluctuations are actually present could be obtained. Reasons are given to show that they might be expected. Other possible explanations given by Langmuir have involved new ideas concerning the interchange of energy between either radiation or excited atoms and electrons which seem improbable and which are not required in the explanation here given.

AUTHOR.

442. *Effect of the Shape of the Kathode on the Glow Discharge.* **W. Stephenson.** (Phil. Mag. 2. pp. 556–577, Sept., 1926.)—Relates to glow discharge produced without positive column in large vessels containing dry air, the electrodes being shaped as follows: (1) Of three straight coplanar parallel wires, the middle and one other form the kathode, the remaining wire forming the anode. (2) A spiral kathode lies on a spherical surface at whose centre is a point anode. (3) Two coaxial cylindrical spirals, one within the other, form the kathode, the anode being an axial straight wire. (4) One electrode is U-shaped and the other a bar, the direction of current being reversible. (5) Two parallel plates, insulated on their outer surfaces, their distance apart being adjustable, form the kathode, the anode being a rod. Four conditions are distinguished: (*a*) "Normal": the parts of the kathode are widely separated and the active area of the kathode adjusts itself so as to maintain a constant current density, the kathode fall being also constant. (*b*) "Abnormal": the parts of the kathode are still widely separated, but the whole area of the kathode is active, and increase in the applied voltage produces increased current density and kathode fall. (*c*) "Heteronormal": the parts of the kathode are so near together that their Crookes dark spaces overlap; part only of the kathode area is active; the current density is greater while the kathode fall is the same as or less than under "normal" conditions; the negative glow is restricted to points lying on normals to the exposed kathode surfaces. (*d*) "Heteroabnormal": the Crookes dark spaces overlap, the whole of the kathode is active, and both current density and kathode fall are greater than under "normal" conditions. In the case where two parallel plates are used as the kathode, the thickness of the Crookes dark space bears a linear relation to the distance apart of the plates which is independent of the gas pressure. The heteronormal effect is explained by assuming that electrons from one kathode enter the dark space of the other so as to produce ions in a strong electric field, as opposed to the weak field in the region of negative glow. The phenomena are related to those obtained by M. E. Hufford at a hole in a kathode. C. W. H.

443. *The Pseudo High Vacuum.* **E. Heermant** and **R. Thaller.** (Zeits. f. Physik, 39. 2–3. pp. 130–135, 1926.)—Adhering to the Güntherschulze [see Abstract 1706 (1925)] definition of a pseudo high vacuum, a case is described how such a condition can be set up with classical Röntgen tubes. A specially constructed tube assists in explaining the phenomenon. From the known cases it must be concluded that the setting up of a pseudo high vacuum is brought about always through positive, the kathode, or negative, the anode, screened electrostatic charges, according to the kind of discharge and the arrangement of electrodes in the discharge vessel. A. E. G.

444. *Theory of the Sparking Potential and of Spark Retardation.* **W. Braunbek.** (Zeits. f. Physik, 39. 1. pp. 6–23, 1926.)—Using Townsend's theory of ionisation by collision, the paper deals with the production of a current of ions—*i.e.* the progress of the sparking phenomenon with the time—in such a way as to include the phenomenon of spark retardation, which has recently been studied by the author and by K. Zuber [see Abstract 1890 (1926)]. It is shown that, using the continuity theory, the time required for an "avalanche" of ions to attain full development by increases due to collisions of ions is far too small to account for the observed spark retardations, which in some cases are as large as ten seconds.

The attempt is then made to explain matters by a statistical method, the conditions being sought which are necessary in order that an ionic avalanche, when once formed, should not run itself out, but should develop to a full spark. The theory developed gives a good interpretation of the observed facts, and shows that the sparking potential can only be strictly defined for an infinitely strong discharge. The laws with respect to spark retardation thus obtained agree well with the most recent observations, although a complete quantitative explanation has not as yet been obtained. H. N. A.

445. *Radiation produced by the Passage of Electricity through Gases.* **J. J. Thomson.** (Phil. Mag. 2. pp. 674–701, Sept., 1926.)—This paper contains an account of experiments on the character of the radiation produced when electric currents pass through gas at a low pressure. The method adopted is to let the radiation fall on a disc of metal and measure the variation in the rate of emission of electrons due to the photoelectric effect when the emission is retarded by an electric field tending to stop the escape of electrons. The theory of the variation of the rate of emission with the strength of the field is worked out, and methods are given for determining from the graph representing the relation between rate of emission and the p.d. in the retarding of the spectrum of the radiation. The radiation produced by the passage of kathode and positive rays through the gas, that from the negative and anode glows in hydrogen, oxygen, helium and argon at different pressures are discussed. It is found that the frequencies of by far the greater part of the radiation are comparable with those corresponding to quanta of the order of the ionising and resonance potentials of the gas; in the case of the radiation due to the kathode rays these radiations are mixed with others of higher frequency. In a few cases the radiation is found to be fairly homogeneous, but in general it is a mixture of radiation having a frequency comparable with that of the ionising radiation with other radiation of a lower frequency. The electrodeless ring discharge is found to be a very copious and convenient source of radiation of this type, and various lecture-room experiments are described for demonstrating the existence and properties of the radiation. A. E. G.

446. *Secondary Emission from Metals due to Bombardment of High-Speed Positive Ions.* **W. J. Jackson.** (Phys. Rev. 28. pp. 524–530, Sept., 1926.)—A beam of K^+ ions from the iron catalyst source discovered by Kunsman was collected in a Faraday cylinder. A target could be interposed at the mouth of the cylinder by a magnetic control. The difference in current measured in these two cases gave the amount of secondary emission. A transverse magnetic field could be applied at the target to prevent emission of electrons and thus separate electron emission from positive ion reflection. The percentage secondary emission due to bombardment of positive ions having speeds up to 1000 volts has been found for three metals—*viz.* aluminium, nickel and molybdenum—under a variety of surface conditions. Heat treatment in general reduced the secondary electron emission. The secondary electron emission could not be detected (was less than 0·5 %) at positive ion velocities less than 200 volts for Al, 300 volts for Ni, and 600 volts for Mo after heat treatment. The secondary emission increased from these values to 7·0 % for Al, 4·2 % for Ni, and 3·8 % for Mo at 1000 volts. Without heat treatment the emission was detected at lower voltages and reached about double the above values at 1000 volts. The secondary electrons emitted were of low speed; a retarding field of a fraction of a volt was enough to stop nearly all of them. In the cases of molybdenum and nickel positive ion reflection did not exceed 2 %, and was undetectable in the case of aluminium. AUTHOR.

447. *Ionisation in Flames.* **E. Marx.** (Ann. d. Physik, 81. 5. pp. 454–492, Oct. 18, 1926.)—In this paper is presented a comprehensive theory of ionisation phenomena in flame gases. From this theory of mobility, thermal ionisation and equilibrium conditions the reaction constants, recombination and dissociation coefficients, etc., can be calculated. The theory is supported by much experimental work. [See also Abstract 2577 (1925).] A. W.

448. *Ionisation in the Upper Atmosphere.* **S. Chapman.** (Roy. Meteorolog. Soc., J. 52. pp. 225–236, July, 1926.)—It has been established that short wireless waves, 500 metres or less, can be reflected downwards at night at remarkably small angles of incidence. Observations of reflection at night, for wave-lengths about 200 metres, indicate that the effective ions are free electrons. Positive molecular ions must also be present, but will take only a negligible share in the bending of the waves. It is shown that the wireless evidence indicates that the upper atmosphere is ionised in a layer of unknown thickness which extends down to 40 or 50 km. above the ground by day, and to about 90 km. by night, the rise of the under surface being due to the progressive recombination of the ions at the lower levels after sunset. The electron density at about 90 km. at night is at least 100,000 per c.c. The greater thickness of the layer by day is obviously due to solar action. The degree of accordance between the wireless and magnetic data for the conducting layer may be considered satisfactory in the present state of knowledge. It is not known definitely what constituent of the air is the one ionised or what is the ionising agent. The sun's ultra-violet radiation is absorbed mainly by ozone, and if, as the discussion here given shows to be quantitatively possible, the ultra-violet radiation is the cause of ionisation, the latter must be effected by the ozone absorption, and ozone must be the ionised constituent. Against this is to be set the apparent unlikelihood of a large increase in the ultra-violet radiation at sunspot maximum, such as seems required by the magnetic data. But the only alternative source of ionisation is corpuscular radiation from the sun, which falls on the sunlit hemisphere without deflection by the earth's magnetic field. Such corpuscular radiation must therefore be electrically neutral, whether ionised or not. It is shown that the spectrum of the aurora constitutes valuable information regarding the composition of the upper atmosphere, though it can only partly be interpreted at present. The auroral spectral green line is discussed. A. E. G.

449. *Proof of Monomolecular Ions in Air and the Existence of Action at a Distance between Ion and Gas Molecule.* **W. Busse.** (Ann. d. Physik, 81. 6. pp. 587–602, Oct. 26, 1926.)—The object of the present paper is to prove the existence of monomolecular ions when the air is so far as possible freed from all traces of water vapour. On the basis of the results given it is concluded that the introduction of action at a distance between ion and gas molecule, as is done by Langevin in the mobility formula of Loeb and Wellish, leads to false relations between ion constants; in fact, that action at a distance between ion and gas molecule, in the sense of Langevin (k/r^5), is not present. A. E. G.

450. *Test of the Existence of the Conducting Layer.* **G. Breit** and **M. A. Tuve.** (Phys. Rev. 28. pp. 554–575, Sept., 1926.)—A method previously proposed for a test of the existence of ionisation in the upper atmosphere has been developed, and a definite proof of the existence of echoes from the upper regions has been obtained. The echoes are present for 70-meter waves with an 8-mile base near Washington, D.C. The effective height of the layer is between 50 and 130 miles. At times multiple reflections are present. Radio fading is shown to be not only an effect of interference between the ground and the reflected waves, but also to a large extent an effect of the presence or absence of reflected waves. A seasonal variation in the effective height between summer and fall seems to exist. A smaller diurnal effect is also suspected. The height seems greater in the fall than in the summer and greater in the afternoon than in the morning. Effects of wave-lengths and of location have been studied. A quantitative discussion of the results enables one to eliminate too gradual distributions of electron density. The measured retardation is shown to correspond to a height greater than the actual by amounts differing for various polarisations of the refracted waves. AUTHORS.

451. *Theory of the Thermionic Effect. Part II.* **N. v. Raschevsky.** (Zeits. f. Physik, 39. 2–3. pp. 159–171, 1926.)—In this paper the author investigates how the ordinary method of treating the problem [see Abstract 832 (1926)], which is based on the properties of electrons deep within the interior of metals, stands in relation to that which considers electronic emission as a surface phenomenon. The mathematical and thermodynamical identity of the two methods is discussed, and a case discovered in which the second mode of treatment is to be preferred. The earlier assertion of the author [see Abstract 1894 (1926)] that the condition for the universality of A in Richardson's formula, $\partial v/\partial n = 0$, is further discussed, and it is established that the potential difference, $\phi - \psi$, of the double layer, neglected for the case $\partial v/\partial n = 0$, is approximately independent of the temperature. A rough calculation is given for the determination of $\phi - \psi$ and of its temperature dependence, and its connection with the theory of metallic conduction is proposed and discussed. H. H. Ho.

452. *Variation with Temperature of the Work Function of Oxide-Coated Platinum.* **M. S. Glass.** (Phys. Rev. 28. pp. 521–523, Sept., 1926.)—A series of tests was made with standard Western Electric VT2 vacuum tubes, in which the filament was held at a higher temperature for a period of five minutes and then returned to a lower reading temperature (950° C.) and the electron current measured with a plate potential of 110 volts. It was found that the previous heating of the filament caused a temporary increase in the electron current over the normal value for that temperature, and that this effect increased with temperature up to about 1130° C., after which point it began to fall off. The results of another series of tests indicate that positive ion emission from the filament begins at a temperature somewhat above that which produced maximum electron current. These results are in agreement with the theory that the thermionic activity of oxide-coated platinum filaments is probably due to a film of metallic barium and strontium produced by reduction of the oxides. AUTHOR.

453. *Natural Fluctuations of the Weakest Photo Currents.* **E. Steinke.** (Zeits. f. Physik, 38. 4–5. pp. 378–403, 1926.)—The fluctuations which occur in the time of charge of a very sensitive Hoffman electrometer, due to the natural fluctuations in the expulsion of electrons caused by light, are investigated. The mean relative fluctuation $\bar{\epsilon}$ is connected with the number of expelled electrons z by the equation $\epsilon = 1/\sqrt{z}$. The strengthening due to ionic collision is used as a method of magnification. The fluctuation equation obtained is based on Poisson's and Bateman's formulæ. The relation between the photoelectric current and the applied potential was ascertained with a constant illumination; then, after each application of a higher potential, several days were allowed to elapse. Illumination was then applied, and an hour later the actual observations were commenced. The fluctuations due to the chance emission of electrons were investigated. It is shown that strengthening of the individual effects by ionisation up to about fifty-fold takes place, and the observed fluctuations agree within 10 % with those calculated from known values of the elementary quanta. With a greater strengthening (*i.e.* with applied voltages 150 to 200) the fluctuations become steadily greater than the calculated ones. T. B.

454. *Total Photoelectric Emission from Metals as a Function of the Temperature of the Exciting Radiation.* **S. C. Roy.** (Roy. Soc., Proc. 112. pp. 599–630, Oct. 1, 1926.)—The dependence of photoelectric emission on temperature is investigated experimentally in the case of eleven elements, and is found to conform to Richardson's law of thermionic emission. The results are discussed theoretically on the view that thermionic emission is due to the photoelectric activity of the radiation of the hot body itself, such radiation being in temperature equilibrium with the body and distributed throughout its mass, whereas the ordinary photoelectric effect is due to radiation of higher temperature than the surface on which it acts and beneath which it fails to penetrate. Theoretical expressions are obtained for the exponential coefficient of photoelectric absorption of radiation, for the yield of electrons produced by radiation of given frequency and amount, and for the total photoelectric current under given conditions. The results are compared with experimental data, and the first of the expressions referred to is shown to be well supported by observations of the optical absorption in silver. C. W. H.

455. "*Kippschwingungen*" *in Electron Tubes. Part II.* **E. Friedländer.** (Archiv f. Elektrot. 17. pp. 103–142, Oct. 9, 1926.)—This paper forms the second part of a communication by the present author on this subject. [See also Abstracts 2179 (1926) and 202 (1927).] The following are the special points here dealt with: Arrangements of three-electrode tubes and transformers; stability relations; oscillation phenomena; $\lambda(k)$ diagram with transformers without scattering; the "Kipp" phenomenon and the complete $\lambda(k)$ diagram; oscillographic and calculated proofs; other tube oscillation arrangements. A. E. G.

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456. *Valve Generators for Short Electric Waves.* **M. T. Grechowa.** (Zeits. f. Physik, 38. 8. pp. 621–634, 1926.)—A continuation of previous work [Abstracts 599 and 833 (1926)]. Using a two-valve generator similar to that previously described, the dependence of the wave-length and the intensity of the oscillations on the general arrangements and on the external oscillatory circuit was investigated, and the conditions under which given harmonics are excited were established. Wave-lengths down to 18 cm. were obtained. Similar arrangements, using a larger number of valves with anodes and also grids connected by straight conductors, were employed. It was found that the intensity of the oscillations increased more rapidly than the number of valves. The largest number of valves used was seven. A. W.

457. *Investigation of Poulsen Arc Generator with Longitudinal Field.* **L. F. Pierce.** (Zeits. techn. Physik, 7. 8. pp. 388–395, and 7. 9. pp. 461–466, 1926.)—After a short discussion of the theory of arc generators, experiments with arcs employing longitudinal fields are described. The physical constants of such arcs under different conditions were measured. The temperatures reached in arcs with longitudinal and with transverse fields were investigated and compared. The results show that relations exist between temperature and frequency, resistance and power, and also between gas pressure and power. The effect of various gases in the arc chamber was very carefully investigated, and a partially new method for investigating arc generators is described. A. W.

458. *Measurement of Amplification of Telephone Line Relay Amplifiers.* **W. Wolff.** (Elekt. Zeits. 47. pp. 1156–1158, Oct. 7, 1926.)—A method is described for obtaining the practical amplification factor of telephone line relays, taking account of the variation with frequency of the line wave resistance. The practical amplification is expressed as the difference between the sum of two known fixed dampings and a variable damping. Several variations of the method applicable to different conditions are described. [See Abstract 1472 (1925).] A. W.

459. *Propagation of Short Waves.* **R. Mesny.** (Onde Élec. 5. pp. 434–459; Disc., 459–463, Sept., 1926.)—After outlining the phenomena which characterise the propagation of short waves, such as great range, zones of silence, influence of night and of the seasons, the author discusses the theories which have been put forward to explain the effects observed. The hypotheses on which physicists rely for justifying the existence of a conducting layer in the upper atmosphere are next discussed, and this is followed by a general treatment of the propagation of waves in an ionised medium, showing how reflection and refraction towards the earth arise. From the general theory an approximate explanation of the observed phenomena is deduced. In conclusion, experiments to test the validity of the theories put forward are dealt with, and the differences which still exist between observed effects and the consequences of the theories advanced to explain them are pointed out. A. W.

460. *Radiation from Complex Antenna Systems.* **M. A. Bontsch-Bruewitsch.** (Ann. d. Physik, 81. 5. pp. 425–453, Oct. 18, 1926.)—The antenna systems dealt with are such as have all wires lying in one or other of three mutually perpendicular directions. For such systems general expressions are derived for amplitudes and phases, and these are applied to find the space distribution of the radiation from various particular systems, including those with combinations of vibrators and reflectors. A. W.

461. *Amplitude of Electrical Vibrations.* **V. Gaponov.** (Zeits. f. Physik, 39. 1. pp. 29–39, 1926.)—The absolute amplitude of electrical vibrations in a spark discharge can be calculated from the potential of the vibrator. The amplitude can also be found from the heating effect if the wave-length does not exceed 30 metres and if the damping, the frequency of current breaks and the number of sparks be known. The last may come to several hundreds in air or several thousands in petroleum, which inhibits arc discharge. A. D.

462. *Reflection of Electromagnetic Waves at Ferromagnetic Surfaces.* **W. Arkadiew.** (Zeits. f. Physik, 38. 11–12. pp. 908–919, 1926.)—The effects of dielectric and magnetic hysteresis are simulated in the case of sinusoidal variation of the field vectors by the assumption that the dielectric and magnetic induction lag behind the electric and magnetic force respectively. In a medium showing these effects, four constitutive constants are then required. The conditions of propagation of plane waves in such a medium are worked out in some detail. In particular the reflection of waves at the surface of a ferromagnetic medium is investigated. The magnetic and electric energies dissipated at the surface are evaluated, and from these the high-frequency resistance of ferromagnetic wires is deduced. W. S. S.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

463. *Measurements by means of Liquid Helium. Part II. The Resistance of Gold, Zinc, Cadmium, Platinum, Nickel, Iron and Silver to about* 1·3° *Abs.* **W. Meissner.** (Zeits. f. Physik, 38. 9–10. pp. 647–658, 1926.)—This investigation has for its object the determination of whether certain metals only are super-conducting or whether all metals have this property at sufficiently low temperatures. The data obtained are of interest as a basis for the theory of electrical conductivity [see Abstract 269 (1926)]. Part I was concerned with constantan, lead, tin and very pure gold. Since Pohl, Gudden and Flechsig had found [see Abstract 1796 (1926)] that the photoelectric conduction in NaCl crystals was as much influenced by imperfect crystal structure as by impurities, special care has been taken in the preparation of very pure perfect crystals, the resistance of which has then been measured at the temperature of liquid helium. Details with data are given at copious length. With the metals taken, no intimation of super-conductivity was observed within the range 1·7—1·3° abs.; on the contrary, cadium of the greatest degree of purity showed the opposite effect, while small admixtures of lead with the cadmium improved the conductivity. From this work it would appear as if only a certain group of metals were super-conducting. The paper is replete with valuable preparative information apart from its main purpose. H. H. Ho.

464. *Dependence of the Electrical Resistance of Nickel Steels upon Composition, Temperature and Heat Treatment.* **F. Ribbeck.** (Zeits. f. Physik, 38. 9–10. pp. 772–787, 1926.)—Literature relating to the specific resistance of nickel steels, containing from 0–100 % of nickel, at 20° C. is briefly reviewed, and particulars given of an experimental determination of the respective specific resistances of iron and nickel for the respective temperature ranges 0°–1000° C. and 0°–500° C. The respective specific resistances of iron and nickel at 0° C. are found to be 8·90 and 10·0 microhm-cm. [See also next Abstract.] J. S. G. T.

465. *Dependence of the Electrical Resistance of Nickel Steels on Temperature, Heat Treatment and Composition.* **F. Ribbeck.** (Zeits. f. Physik, 38. 11–12. pp. 887–907, 1926.)—This paper gives the results of measurements of the electrical resistance of nickel steels in the temperature range 0 to 300° C. For the irreversible steels, (nickel content less than 30 %) the resistance was measured in the two states corresponding to the following heat treatments: (α) glowing for one hour at 800° C. and then cooling very slowly; (β) glowing at 800° C., exposing to a stream of air for a few minutes and then allowing to cool. The increase of specific resistance after either heat treatment and for all the steels was of the same order, and amounted to about 0·075 microhm-cm. per degree. After treatment (α) the specific resistance at 0° C. was found to increase with increasing nickel content from $1\cdot10^{-5}$ for pure iron to about $8\cdot5\ .\ 10^{-5}$ for steel containing 29·9 % nickel. An increase in the carbon content was accompanied by an increase in the resistance. The resistance after treatment (β) was found to be about half that following treatment (α). Measurements on the irreversible steels were also made during the transformation process. The steels after glowing at 800° C. were immersed in air until the glow disappeared and then transferred immediately to an oil bath at 300° C., the resistance measurements being made during the subsequent cooling. For those steels with transformation temperatures in the range 0–300° C. corresponding kinks in the resistance cooling curves were obtained. The results for reversible steels (containing more than 30 % nickel) showed in all cases normal positive temperature coefficient, with decrease of specific resistance as the nickel content increased. The consideration of the complete measurements, which cover a range from −185 to 1000° C., is postponed. [See also preceding Abstract.] W. S. S.

466. *Some Electrical Properties of Copper-Nickel-Manganese Alloys.* **N. B. Pilling.** (Am. Electrochem. Soc., Trans. 48. pp. 171–186; Disc., 186, 1925.)—Temperature coefficient of resistance, specific resistance and thermoelectric power against copper were measured on thin cast rods of copper-nickel-manganese alloys, up to a maximum manganese content of 80 %. A wide diversity of zero temperature coefficient alloys is disclosed, which, if limited by low thermoelectric power, restricts the malleable alloys to practically two fields, potentially useful for high-grade resistance alloys. One of these fields has not been exploited. No alloys superior in thermoelectric power to 50 % copper-nickel appear to exist in the ternary series. Specific resistance is largely determined by the manganese content, and rises to a maximum of about 140 microhm/cub. cm. at the limit of cold workability. AUTHOR.

467. *Photoelectric Properties of Thin Films of Alkali Metal. Part II. Phenomena at High Temperatures.* **H. E. Ives.** (Astrophys. J. 74. pp. 128–135, Sept., 1926).—A platinum ribbon in an atmosphere of cæsium vapour is heated to various temperatures up to incandescence by the passage of an electric current. By keeping the vapour pressure of the cæsium low by cooling the walls of the tube, thermionic currents and photoelectric currents, caused by illuminating the ribbon, are obtained of the same order of magnitude, and their variation of temperature determined. Both thermionic and photoelectric currents increase with temperature to a sharp maximum and then decrease to negligible values. Consideration of the relative magnitudes of the two currents leads to the conclusion that the thermionically emitted electrons cannot be due to an internal excitation. [For Part I see Abstract 661 (1925).] AUTHOR.

468. *Dielectric Constants of Liquids and Liquid Mixtures.* **L. A. Sayce** and **H. V. A. Briscoe.** (Chem. Soc., J. pp. 2623–2627, Oct., 1926.)—The dielectric constant of seventeen organic liquids and for nine binary mixtures was determined. The method of measurement was the one previously described [see Abstract 1477 (1925)], but certain improvements were made in the apparatus which increased its convenience and speed of operation. The method of measurement is described in detail, and the numerical results obtained are given, but the discussion of the results is deferred until further data are available. F. J. B.

469. *Dielectric Constant of Petrols and Paraffins.* **H. Pécheux.** (Comptes Rendus, 183. pp. 530–532, Sept. 27, 1926.)—The dielectric constants are determined by a method employing a Sauty bridge, damped oscillations being produced by a Ruhmkorff coil. With the liquid petrols the dielectric constant increases with the density, the negative temperature coefficient increasing in absolute value with the dielectric constant. With the hard paraffins the dielectric constant increases with the density, but the temperature coefficient, still negative, decreases with increase of the dielectric constant. The temperature coefficients are negative for all the substances examined, and are from two to three times greater in absolute value for the petrols than for the paraffins. A. B. C. L.

470. *Temperature Dependence of the Dielectric Constants of Quartz, Fluorspar and Gypsum.* **A. Dieterich.** (Ann. d. Physik, 81. 5. pp. 523–536, Oct. 18, 1926.)—The method of measurement employed was that of resonance in oscillating circuits as being more sensitive than the bridge method and therefore better suited for dealing with small rises in temperature. The investigations were carried out at intervals of temperature ranging from 10 to 50° C. The frequency of the oscillations was in most of the experiments about $6 \cdot 4 \times 10^5$, but occasionally 4 and $9 \cdot 7 \times 10^5$. Within observational errors the temperature coefficients were found to be independent of the mean temperature of experiment and of the frequency. Corrections being made in every case by deducting the thermal coefficient of expansion, the following constants were established: Fluorspar $+ 2 \cdot 5 \times 10^{-4}$; gypsum $+ 3 \cdot 75 \times 10^{-4}$. With quartz the influence of temperature on capacity was much less and the accuracy of measurement correspondingly smaller. As the result of twenty measurements the constant was found to lie between $+ 1 \cdot 7$ and $+ 2 \cdot 5 \times 10^{-5}$. As, however, the correction for thermal expansion amounts to $- 2 \times 10^{-5}$, all we can say with certainty is that the temperature coefficient of the dielectric constant must be very small. This contradicts the statement of Hasenoehrl that quartz has a very considerable negative dielectric temperature coefficient of $- 1 \times 10^{-3}$. The discrepancy may be accounted for by the fact that he used small condensers of about 7 cm. capacity, whereas those used by the author had a capacity of 100 cm. Reference is made to a paper by Gagnebin in which it is found that between 220° and 300° the dielectric constant is increased 2·8 times and above 300 nearly constant. As this came to the author's notice only after the conclusion of the present investigations, he was not able to subject the behaviour of quartz at high temperatures to experimental test. Glass was used as a control and found to have lower dielectric temperature coefficients than those given by other observers. This is probably owing to the fact that alternating currents of high frequency were used. It is also worthy of note that the coefficient of Minos glass is only half that of the ordinary glass examined. E. F.

471. *Control of Oven Temperature.* **Verney.** (Comptes Rendus, 183. pp. 561–562, Oct. 4, 1926.)—Describes an apparatus by which the temperature of an oven can be varied according to any desired temperature time curve. A graph of the actual temperatures attained in a given case accurately reproduces the original curve. G. A. S.

472. *The Creep Galvanometer.* **H. Busch.** (Zeits. techn. Physik, 7. 8. pp. 361–371, 1926.)—When a galvanometer is used for ballistic work conditions are usually so arranged that the damping term and the restoring term are so small compared with the inertia term in the equation of motion that they may be neglected in comparison. The effect is to make the motion very slow, and a considerable amount of time is taken up by a series of observations. An alternative method of obtaining the desired result is to make the damping term far outweigh the others in importance, as can easily be attained by using a moving coil galvanometer with only a small external resistance to close the circuit. In this case the time of flow of electricity need not be small, the coil need not return to its zero position between the successive discharges, and the change of induction producing the throw is proportional to the throw and independent of the resistance in the circuit. A resistance of the system of about 250 ohms is found very suitable for a particular galvanometer tested, the errors involved by the neglect of the inertia and restoring terms in this case being less than 2 in 1000. The sensitivity of the galvanometer, when used with an inductance coil, is shown to be effectively of the same order whether it is used as a creep galvanometer or in the ordinary way, since the smaller sensitivity in the creep case is compensated by the smaller closing resistance. When used for capacity measurement, the sensitivity of the creep galvanometer is only about 1/20 of that of the ballistic galvanometer. It is also shown that the creep galvanometer for capacity measurements, especially with poor condensers, is superior to the ballistic type in that, as it reaches its turning point in a much shorter time, residual dielectric effects do not seriously affect the value of the throw. G. A. S.

473. *Use of a Resonant Shunt with an Einthoven String Galvanometer.* **S. Butterworth, A. B. Wood** and **E. H. Lakey.** (Journ. Sci. Instruments, 4. pp. 8–18, Oct., 1926.)—The paper gives the theory of the action of a resonant shunt when used with an Einthoven string galvanometer, and records are given showing agreement with theory. In order to use a resonant shunt as a damping device, the following rules must be observed : The shunt constants must be so chosen that the free electrical oscillation in the shunt when short-circuited is an exact copy of the free mechanical oscillation of the string when short-circuited. This fixes the values of LC and of R/L for the shunt. The absolute value of L depends upon the degree of damping required, small inductances yielding large dampings. For practically undamped strings, critical damping is obtained if the coil reactance at the resonant frequency of the string is equal to one-half the resistance of the string. If the geometric mean between the coil reactance and the critical resistance of the string is equal to one-half the actual resistance of the latter, the degree of damping is the same as if the galvanometer were on short-circuit. In this case also the combination of galvanometer and shunt possesses no back electromotive force. AUTHORS.

474. *New Apparatus for Measuring Small and Minimum Capacities.* **J. Tagger.** (Phys. Zeits. 27. pp. 569–574, Sept. 1, 1926.)—The Harms condenser not being sufficiently accurate in its action for measuring the small capacities which have to be dealt with nowadays, the author has devised an apparatus for which he claims greater precision and simplicity. Its underlying principle is a return to the old method of measurement by means of a sphere. Full constructional details are shown in a drawing which should be consulted in the original. Reference is made to Wulf's calibrated condenser (Phys. Zeits. 26. p. 353, 1925). E. F.

ALTERNATING CURRENTS AND MAGNETISM.

475. *Resistance of a Network containing Inductances and Capacities.* **E. B. Moullin.** (Cambridge Phil. Soc., Proc. 23. pp. 391–402, Oct., 1926.)—A purely mathematical discussion of a generalised filter circuit. Particularly it is desired to determine whether the rejector or acceptor properties of a circuit to an applied e.m.f. in one member will be modified if the e.m.f. be applied in another member. The analogy with certain mechanical systems, such as flywheels on an elastic shaft or coupled spring systems, is shown throughout. A. Wh.

476. *Calculation of the Inductance of Coils.* **K. F. Müller.** (Archiv f. Elektrot. 17. pp. 336–353, Oct. 25, 1926.)—After deriving certain reduction formulæ for the required elliptic integrals an expression is obtained for the coefficient of mutual induction between two coaxial single-layer cylindrical coils. It is shown that Kirchhoff's formula is not correct, and the correct formula is given. In the next section of the paper formulæ are obtained for the radial and axial components of the magnetic field of a circular current or of a single-layer cylindrical coil at any given point. In the last section formulæ are given for the mutual inductance between concentric circular flat coils lying in the same plane. **Errata** (*ibid.*, 17. p. 536, Jan. 6, 1927). A. W.

477. *The Influence of Dampings on the Frequencies of Two Coupled Circuits.* **B. van der Pol., Jr.** (Zeits. f. Hochfrequenztechn. 28. 1. pp. 12–15, 1926.)—The equation for the dampings and frequencies of two coupled circuits is of the fourth degree, and was dealt with in 1897 by M. Wien for the case where the two free frequencies are close to one another and the dampings and the coupling are small. The solution is somewhat complicated, and by means of a series of approximations the author arrives at a simpler form of solution, which is practically satisfactory. The results are presented in a series of curves which show how the dampings and the frequencies vary with the tuning of the circuits for couplings varying from a loose coupling, represented by $k^2 = 0 \cdot 001$, up to a coupling with $k^2 = 0 \cdot 025$. There is a critical coupling such that at the resonance point, where $W_1 = W_2$, the system has only one frequency, equal to the resonance frequency, for couplings below the critical, and two different dampings. For couplings above this point there are two frequencies but only one damping, which is the mean between the two original dampings. For other conclusions and for the mathematical treatment the original paper should be consulted. H. N. A.

478. *Piezoelectric Resonance Phenomena.* **A. Scheibe.** (Zeits. f. Hochfrequenztechn. 28. 1. pp. 15–26. 1926.)—Gives a historical review of the subject, and calls attention to the acoustic methods of determining the occurrence of resonance between the alternating voltage applied to electrodes on a suitably cut rod of quartz or Rochelle salt and the longitudinal vibrations produced in the rod by the consequent alternating changes in mechanical pressure. The absorption method of Cady is also described and that of Giebe and Scheibe, which places the rods in a neon tube at reduced pressure and observes the luminous phenomena produced on its surface at the nodes. A graduated series of such rods can be used to determine the frequency of electric oscillations, and this is shown to be superior for the purpose to the Cady method. Piezoelectric apparatus for stabilising the frequency of a valve transmitter is described, together with different forms of piezoelectric oscillographs, some of which can be used in the investigation of high-frequency alternating voltages. H. N. A.

479. *Piezoelectric Quartz Resonator and Equivalent Electrical Circuit.* **D. W. Dye.** (Phys. Soc., Proc. 38. pp. 399–457; Disc., 457–458, Aug., 1926. El. Rev. 99. 733–735, Oct. 29, 1926. Abstract.)—The quartz piezoelectric resonator is examined experimentally and theoretically with special regard to an equivalent electrical circuit which can represent it. It is shown that, as theoretically predicted by Butterworth, such a resonator can be represented by an inductance, a resistance and a capacity all in series. These are pictured as in parallel with another small condenser, and the whole is in series with a third condenser, the additional condensers representing air gaps. On this representation almost perfect agreement exists between the forms of current curve obtained theoretically and experimentally. The logarithmic decrement of such resonators can be obtained from a line plotted from observations of the current in the oscillatory circuit as a function of frequency width across the crevasse which pierces the summit of the resonance curve. The effects on the response frequency of variation of the air gap were studied, and the slight difference between prediction and observation is discussed. In the case of transverse resonators remarkable effects were observed when the air gap is varied through regions where its length is an integral number of half-wavelengths of the supersonic air waves produced by the vibration of the quartz. The temperature coefficient of the frequency of a considerable variety of resonators was examined over a range of temperatures up to 40° C. Very diverse results were obtained and probable explanations are offered. The temperature coefficients are not negligible except for longitudinal resonators of suitable shape. The coefficients are those to be expected from the known coefficients of Young's modulus with temperature. A. W.

480. *Paramagnetism at Low Temperatures.* **L. C. Jackson.** (Roy. Soc., Phil. Trans. 226. pp. 107–133, Sept. 21, 1926.)—In continuation of work on the principal susceptibilities of crystals [see Abstracts 665 and 989 (1924)], a greater degree of accuracy is attained in the determination of the Δ constants, which are functions of the spacing of the paramagnetic atoms in the crystal. Crystals of cobalt potassium sulphate, nickel ammonium sulphate, and manganese ammonium sulphate were suspended from the arm of a Petterson quartz microbalance which served to measure the attraction in a non-uniform magnetic field. The liquid-air cryostat was of the type used by Keyes and Young, and the attracting coil was carefully made so that the value of $H dH/dx$ could be found from the coil dimensions and the current strength. The values of $1/\chi$ for the principal susceptibilities of cobalt potassium sulphate lie on three approximately parallel straight lines; this agrees with previous results. The mean of the principal susceptibilities of this crystal follows the law $\chi(T + \Delta) = \text{constant}$, where $\Delta = 19$. The mean susceptibility per unit mass is $25{\cdot}3 \times 10^{-6}$, as compared with $29{\cdot}2 \times 10^{-6}$ found by Finke. The principal susceptibilities of nickel ammonium sulphate follow a similar law, and this substance has a mean susceptibility of $10{\cdot}7 \times 10^{-6}$ at atmospheric temperature. G. E. A.

481. *Influence of Constant Magnetic Field on Magnetic Spectra.* **W. K. Mitiaev.** (Zeits. f. Physik, 33. 9–10. pp. 716–726, 1926.)—With iron wires, a field up to 600 gauss diminishes the magnetic permeability μ_k in the region of electromagnetic waves from 55 to 114 metres. The permeability μ_k and the positions of the dispersion bands remain unaltered. A. D.

482. *Single Iron Crystals. Part I. Magnetisation Curves.* **W. Gerlach.** (Zeits. f. Physik, 38. 11–12. pp. 828–840, 1926.)—This paper contains a very complete description of an investigation of the magnetic properties of large single iron crystals in bar form. It is shown that abnormal magnetic behaviour is not bound up with single crystals as such, but depends on the disposition of the element magnetons. The sections of the paper deal very completely with the material, demagnetisation factor, magnetometric measurements of single crystals, initial permeability, remanence and coercive force, magnetic after-effect, investigation of the separate parts of a poly-crystal, influence of mechanical deformations, mechanical and thermal variations of hysteresis, Gumlich's experiment, and certain other investigations in this field. Nine diagrams are included in the paper. H. H. Ho.

483. *Magnetic Moments of the Alkali Metal Atoms.* **J. B. Taylor.** (Phys. Rev. 28. pp. 576–583, Sept., 1926.)—The work of Stern and Gerlach [see Abstract 1494 (1925)], in which they determined the magnetic moments of certain atoms and at the same time furnished direct evidence of the theory of space quantisation, by deflection of rays of the atoms in an inhomogeneous magnetic field, has been repeated for silver atoms. A simplified apparatus is described, using a silver-plated tungsten coil as source of atoms rather than the furnace used by Stern and Gerlach, which gives trouble in outgassing. The apparatus was further modified for use with the alkali metals by construction of a liquid-air cooled target for receiving the atomic rays and a pyrex glass device for holding the molten metal during evaporation. The images of the rays on the glass target were made visible by immersing in hydrochloric acid gas, which "fixed" them as the opaque and visible chloride. Distinct images of the separated rays resulting from the action of the magnetic field on the oriented atoms have been obtained and are reproduced. Measurements of the separations show that, within the experimental error, sodium and potassium possess magnetic moments equal to one Bohr magneton, in accord with spectroscopic predictions. AUTHOR.

484. *Structure of the Atomic Magnet. Rotation and Reversal of the Multiplet.* **R. Forrer.** (Comptes Rendus, **183.** pp. 559–560, Oct. 4, 1926.)—The magnetic changes which take place during a hysteresis cycle are correlated with the behaviour of the multiplets [see Abstracts 2703, 2704 (1926)]. G. E. A.

485. *Magnetic Susceptibility of Gases and the Influence of Pressure and Temperature.* **E. Lehrer.** (Ann. d. Physik, **81.** 3. pp. 229–261, Sept. 17, 1926.)—The manometric method employed by Bauer and Piccard [see Abstract 534 (1921)] is adopted; the change in pressure of the gas produced by the magnetic field is measured by means of a sensitive Heis manometer [see Abstract 2882 (1924)]. The gases dealt with were oxygen, air, carbonic acid, argon and hydrogen. Within the temperature range 0° to 250° the Curie law holds for oxygen; for the same range the specific susceptibility of CO_2 and Ar, and probably also hydrogen, remains constant. The change in volume susceptibility caused by temperature was, in all cases, proportional to the pressure, and the anomaly in this respect found by Glaser [see Abstract 1122 (1926)] was not observed. Wiedemann's law was found to hold for gaseous mixtures. The absolute values are in satisfactory agreement with those of Soné and of Wills and Hector [see Abstract 1936 (1924)]. G. E. A.

486. *Magnetic Susceptibility of Rubidium Bromide, Cæsium Iodide, Krypton and Xenon.* **Louise Crow.** (Roy. Soc. Canada, Trans. **19.** Sect. 3. pp. 63–70, 1925.)—According to Joos, it should be possible to estimate the susceptibilities of the rare gases from those of the halides of the alkali elements [Abstract 987 (1924)]. These values have been verified in the cases of helium, argon and neon [Abstract 425 (1925)]. The above salts were chosen because the atomic numbers of their constituent elements differed only by unity from that of krypton and of xenon. The method employed was that of weighing the substance, in finely powdered form, in a magnetic field, mercury being used as a standand. The values found for the molecular susceptibilities were: cæsium iodide, $-77 \cdot 6 \times 10^{-6}$; rubidium bromide, $-62 \cdot 9 \times 10^{-6}$. By interpolation the volume susceptibilities of krypton and xenon at 760° mm. and 20° C. are $-13 \cdot 1 \times 10^{-10}$ and $-16 \cdot 2 \times 10^{-10}$. The atomic susceptibilities of potassium, rubidium and cæsium were found to be respectively $-1 \cdot 9 \times 10^{-6}$, $-7 \cdot 0 \times 10^{-6}$ and $-8 \cdot 0 \times 10^{-6}$ at 20° C., *i.e.* all three alkali metals are diamagnetic. G. E. A.

487. *Are Gaseous Molecules Orientated in a Magnetic Field?* **K. S. Krishnan.** (Indian Assoc. for Cultivation of Science, Proc. 10. pp. 35–44, Aug., 1926.)—The anomalies noted by Glaser in the susceptibilities of diamagnetic gases [see Abstracts 607 (1925) and 1122 (1926)] are attributed by him to orientation of the gaseous molecules under the action of the magnetic field. If this is the case, the medium will become anisotropic and doubly refracting. An interference method failed, however, to detect any change in refractive index when a strong magnetic field was put on. Further, the calculated values of the effects due to orientation show that these are too great to escape detection if they existed. The author therefore concludes that gas molecules are not orientated in a magnetic field. G. E. A.

488. *Records from British Magnetic Stations, Underground and Surface.* **C. Chree** and **R. E. Watson.**—(Roy. Soc., Proc. 112. pp. 305–313, Sept. 1, 1926.)—A comparison is made of magnetic observations taken at the observatories at Kew, Eskdalemuir and Lerwick, and on the surface and at a depth of 1800 ft. in a coal mine at West Bromwich, for (*a*) regular diurnal inequalities and (*b*) the amplitude of irregular short period changes. It was concluded that in a coal mine where the local disturbance is absent or very small the declination changes for practical purposes are the same as at the surface. Further, for (*a*) it was shown that the amplitude increased as one moved northwards in summer and decreased in summer. Rucker and Thorpe's assumptions in their magnetic survey that (1) the regular diurnal inequality is independent of distance, and may be treated as identical over the British Isles, provided allowance be made for the difference in local time, and (2) irregular movements may be treated as identical over the same area, are found not to hold, especially if Kew data were used for northern Scotland. R. S. R.

489. *The 27-Day Recurrency in Earth Currents.* **W. J. Peters** and **C. C. Ennis.** (Terrest. Magn. 31. pp. 57–70, June, 1926.)—The data analysed are the observations on earth currents published by the Ebro Observatory in Spain from 1910 to 1924. It is found that the highest and lowest values of the daily range in earth currents are not followed 27 days later by high and low values. But over a number of years the mean value on the 27th day after a high value is high and similarly for low values. Comparable but less pronounced effects are also associated with the 54th and 81st days. Some suggestions are offered as to the possible relationships between the effects and the period of the sun. A. A. D.

490. *Recurrence of Magnetic Storms.* **C. Chree.** (Nature, 118. pp. 335–336, Sept. 4, 1926.)—It has been supposed by Deslandres that magnetic storms have a tendency to follow each other at intervals of $iT/6$, i being integral and T the rotation period shown by sunspots. Since a periodicity of T or multiples of T suggests discharge of ions from the spots or fixed limited areas, whereas periodicity in shorter periods points to a different origin, the data for a number of years have been examined and tabulated. The 27-day period is fully confirmed, but the results do not, according to the author, suggest any real recurrence interval shorter than this. W. V. M.

491. *The Law of Distribution in Time of Magnetic Storms.* **H. Deslandres.** (Comptes Rendus, 183. pp. 493–497, Sept. 13, 1926.)—The views advanced in a series of preceding papers [see Abstract 2710 (1926)] have been criticised by Chree [see preceding Abstract]. In the present paper the author defends his standpoint and cites other series of magnetic storms which are in accordance with his ideas, particularly a group which occurred in the middle of 1926. He quotes in support a paper by Buss in which it is shown that sunspots are distributed in groups on the sun with differences of longitude of approximately 60°.

A. A. D.

492. *Recurrence of Magnetic Storms.* **H. Deslandres.** (Nature, 118. pp. 621–622, Oct. 30, 1926.)—An answer to a previous communication by Chree [see Abstract 490 (1927)]. The author gives experimental evidence for the existence of the shorter period in the recurrence of magnetic storms and points out that the method used by Chree is not suitable for the detection of periodic inequalities whose intensity is very variable. The author discusses the helicoidal trajectory of the corpuscles thrown out from the sun and thus explains the polarity of the protuberances and double polarity of spots. W. V. M.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

493. *The General Principles of Irradiation and of Radiation Field Direction in Transcutaneous Radium Therapy.* **L. Mallet.** (Arch. d'Él. Médicale, 34. pp. 305–325, Aug.–Sept., 1926.)—The author describes a system of cross-fire radiation for deep therapy with the γ rays of radium. Essentially this method is the same as that used in deep-therapy X-radiation treatment. Isodosis curves are drawn up for the γ radiation, and these are utilised, with sectional diagrams of the human body, by a method similar to that associated with the name of Holfelder in X-ray therapy. The radium is applied in lead containers, corresponding to the fields of radiation of X-ray therapy, to give cross-fire effects. Photographs of the focussing radium containers and their methods of application are shown. A unit of intensity is introduced with the designation D, which appears to be the same as the French R unit for X-radiation intensity. Tables of intensity of dose at various depths are given. These tables and the paper in general should be of great value to all engaged in radium therapy. B. J. L.

494. *Edinburgh Royal Infirmary. A Modern Radiological Department.* (El. Rev. 99. pp. 703–707, Oct. 29, 1926.)—This article is very largely pictorial, and shows the equipments of the X-ray, ultra-violet light, electrical treatments and massage departments of this institution. The installation is the largest of its type in Great Britain. The department comprises all the features of modern requirements as regards protection against electrical shock, protection against X-radiation (by means of barium plaster to a lead equivalent of 5 mm.), elimination of noxious fumes, etc. B. J. L.

495. *Radiological Research Laboratory.* **E. P. Vanoni.** (Elettrotecnica, 13. pp. 697–702, Oct. 25, 1926.)—This is an account, with illustrations, of a recently instituted research laboratory. The work undertaken falls into four sections: (1) Investigating electrotechnical apparatus, including measuring instruments and schemes for very high-tension work; (2) various kinds of tubes, including thermoelectric valves; (3) the measurement of radiations, the study of means of protection and of fluorescent screens; (4) a general research section.

A. E. G.

496. *The Significance of Electro-Cardiographs.* **F. Henrijean.** (Comptes. Rendus, 183. pp. 671–673, Oct. 18, 1926.)—In a previous paper [see Abstract 1982 (1925)] certain results were obtained as regards the fundamental phenomena upon which the electro-cardiograph curve is dependent. It is difficult to reconcile these previous results with facts that further research has brought to light. For example, a heart which still gives an electro-cardiograph curve is not completely arrested but still in a state of weak contraction. This is difficult to reconcile with the view that the electro-cardiograph curve is purely of muscular origin. The actions of various agents and drugs as salts of calcium and potassium are discussed at length. The author concludes the P and R waves of the cardiograph are less closely connected than is usually thought. The action of the P wave upon the R wave is more dependent upon the nœud of Tawara, and its state of reception, than actually upon the P wave, whilst the R wave has a more constant action upon the P wave. On the contrary, one may often observe isolated P waves, whereas nodal waves, without the P waves, are exceptional. B. J. L.

497. *Ultra-Violet Rays in Medicine.* **P. Cottenot.** (Soc. Franç. Élect., Bull. 6. pp. 1188–1194, Oct., 1926.)—A very well-balanced review of the use of ultra-violet light in medicine. The question of antagonism of infra-red and ultra-violet rays is considered, and the author states that at present there are so many contradictory reports that a definite opinion cannot be given at this stage. The biological actions of ultra-violet radiation are given and the question of sensitisation by eosin considered. The therapeutic results are to be published in "Le Bulletin de la Société Française d'Électrothérapie et de Radiologie." In his conclusion the author points out that whilst ultra-violet radiation is at present in vogue and all kinds of extravagant claims are being made, it has a very definite value in order to place the organism in normal conditions as regards sunlight and to prevent diseases due to lack of sunlight. B. J. L.

498. *The Electrolytic Introduction of Medicaments.* **A. Laquerrière.** (Soc. Franç. Élect., Bull. 6. pp. 1195–1201, Oct., 1926.)—An historical account is given of the introduction of drugs into the human tissues by electrolysis (medical ionisation). The subject of electrolytic conduction in the tissues is discussed. When electrodes impregnated with certain drugs are used, whilst electrical theory predicts no deep conduction of the dissociated drugs into the tissues, it can be shown such penetration occurs, the drugs being recovered from the urine, etc. Similarly it has been shown by Leduc that with electrodes saturated with potassium cyanide and with strychnine sulphate, whilst no ill effects are produced in rabbits with one direction of current flow, on reversal of the current, these drugs enter the tissues of the rabbits and cause death. The physical objections to any view of direct electrolytic conduction are considered and the view held that the passage of medicaments is due to a circulation of water within the body itself which transports the medicaments introduced by the electrical current into the superficial tissues. The impossibility of using heavy current strengths, owing to disagreeable sensations and burns, limits the field of application of ionisation. B. J. L.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

499. *Adsorption and Diffusion in an Electrical Field.* **J. Gicklhorn, R. Fürth** and **O. Blüh.** (Zeits. phys. Chem. 123. pp. 344–362, Oct. 6, 1926.)—A method of determining the sign of the electrical charge on particles of dyes was developed. It consisted in employing strips of filter or blotting-paper, saturated with water, as electrodes, and applying a potential of 100–600 volts direct current to the upper end of the electrode. When the electrode was removed after 1–2 minutes electrolysis in a dye solution, one electrode was found to be coloured most strongly at the immersion level, while the other electrode was either uncoloured or only slightly coloured under the conditions of experiment. The particles of the dyestuff are positively charged, when the negative electrode is coloured, and negatively charged in the reverse case. The method was applied to the study of the behaviour of electrolytes and non-electrolytes and to the polar adsorption of gases. F. J. B.

500. *Gas-Liquid Bounding Surfaces.* **A. Frumkin, A. Donde** and **R. Kulvarskaya.** (Zeits. phys. Chem. 123. pp. 321–338, Oct. 6, 1926.) —It has been ascertained that in solutions of aliphatic compounds with saturated carbon-chains and terminal polar groups the carbon-chain lies flat on the surface so far as the degree of concentration allows sufficient room, while the polar group is drawn into the interior of the liquid. The present inquiry takes in a number of aromatic compounds. Harkins has discussed the various orientations of substituted benzol molecules from surface tensions of aqueous solutions. The authors confirm Harkins' results in part, but their use of both electric and capillary methods shows the phenomena to be more complicated than these results would indicate. Writing the superficial tension as Δ, the air/solution p.d. as ϵ and the concentration as c, we have: The Δ, c curves for *o*-, *m*- and *p*-cresol, benzyl-alcohol, aniline, *o*- and *p*-toluidine, benzoic acid, phenyl-acetic acid, hydrocinnamic acid present within a certain range of concentration a change-point, and do not correspond to Szyskowski's equation; but the authors' previous equation for aliphatic compounds, which takes account of attractive forces in the superficial layer, is found to apply. The adsorption of these compounds is less than that of the corresponding aliphatic compounds with equal numbers of carbon-atoms. The introduction of a CH_3 group lowers the adsorption to an extent which depends upon the position of the CH_3 group. Compounds such as phenol, cresols, anisol, nitrobenzol, aniline, methyl- and dimethyl-aniline, toluidine, which have a polar group in the nucleus, charge the water-surface positively, but much less so than the corresponding aliphatic compounds. Increasing the number of polar groups in the nucleus lowers the charge still further, and in some cases (dioxybenzol, *m*- and *p*-nitrophenol) makes it negative. When the substitutions are in the lateral chains (benzoic acid, methyl benzoate, benzyl alcohol, benzylamine) the charges are very much the same as with the corresponding aliphatic compounds. With increasing dilutions, these last two classes of compounds (with the exception of *o*-cresol, for which the relations are more complicated) present first a slow, then a very rapid fall in the charge. The isomers which occupy the least room on the surface-layer give rise to the most positive charges; para-compounds less positive charges or (dioxybenzol and nitrophenol) greater negative charges than the corresponding ortho-compounds; but the differences are too great to be accounted for by orientation, and we must admit that the molecules of the isomers have different electric moments. [See Abstract 3068 (1924).] A. D.

501. *Solubility and Rate of Solution of Oxygen in Silver.* **E. W. R. Steacie** and **F. M. G. Johnson.** (Roy. Soc., Proc. 112. pp. 542–558, Oct. 1, 1926.)—Quantitative determinations of the solubility of O in Ag are carried out between temperatures 200° C. and 800° C. and between pressures 5 cm. and 80 cm. Hg. The solubility is proportional to the square root of the pressure, the solubility-temperature curve having a minimum at 400° C., above which it is expressed by $1/Q = K(930 - t)$, where Q = solubility and t = temperature (° C.). The equation $K = 1/t\{\log S/(S - X) - C\}$, where S is the saturation concentration, X is the amount dissolved in time t, and K and C are constants, expresses the experimental results obtained for the rate of solution, which varies as the square root of the pressure. The variation with temperature is complex and suggests a transition in Ag or a change in the manner of combination of the O at about 400° C. By comparison with diffusion measurements, the concentration gradient of O in a silver plate through which the gas is diffusing is calculated. Nitrogen is shown to be insoluble in Ag. A. B. C. L.

502. *The Influence of Concentration on Protective Colloids.* **S. Sugden** and **M. Williams.** (Chem. Soc., J. pp. 2424–2432, Oct., 1926.) Determinations are made of (1) the concentrations of the electrolytes, barium chloride, sodium chloride, and sodium sulphate necessary to precipitate the electro-negative sol, arsenious oxide, and the electro-positive sol, aluminium hydroxide, in the absence of protective colloid; (2) the concentration of the protective colloids, gelatine and blood serum, required to cause mutual precipitation between the two colloids in the absence of electrolyte; and (3) the concentration of a protective colloid beyond which mutual precipitation ceases. In dilute solutions, protective colloids sensitise the sol and at suitable concentrations cause precipitation in the absence of more than traces of electrolyte. At higher concentrations the colloid exerts a protective effect which reaches a maximum at a definite concentration of electrolyte. For arsenious sulphide sols with concentrations of less than 1 gm. per litre, the amount of gelatine which causes maximum precipitation is proportional to the arsenious sulphide content. The areas of coagulation are plotted, and in all cases the diagrams are of similar characteristic shape. [See also Abstract 2612 (1924).] J. N. P.

503. *Velocity of Spreading of Oil on Water.* **E. Landt** and **M. Volmer.** (Zeits. phys. Chem. 122. pp. 398–404, Aug. 20, 1926.)—Unlike pure olive oil, commercial olive oil contains a small proportion of fatty acids and spreads out on water practically only as two-dimensional liquid phase and not as molecular disperse phase. When a drop of the commercial oil is placed on the surface of pure water on which talcum powder has been dusted, the velocity with which the oil spreads diminishes at first rapidly and afterwards slowly as the radius of the film increases. Theoretical considerations are advanced in accord with the results obtained. Calculation indicates that the transference of an adsorbed substance on liquid surface is of the order 1000 times as great as that on a solid surface. [See Abstract 1925 (1926).] T. H. P.

504. *Limiting States of Alloys.* **L. Grenet.** (Comptes Rendus, 183. pp. 600–603, Oct. 11, 1926.)—It is remarked that the conditions obtaining at the phase boundaries in such alloys as the ferro-aluminiums, ferro-cobalts, ferro-nickels and Fe-rich ferrosilicons have been insufficiently studied, and, using the latter as example, hypotheses are formulated which permit of consideration and representation of the limiting states of alloys. A. B. C. L.

505. *Scope of Organic Chemistry.* **J. F. Thorpe.** (Nature, 118. pp. 483–486, Oct. 2, 1926. Presidential Address delivered before the British Assoc., Oxford, Aug., 1926.)—An account of the present position and of the lines to be followed in future research in organic chemistry, particularly in regard to structural problems, biochemistry, petroleum, and dyestuffs and intermediates. T. H. P.

506. *Method for the Study of Chemical Reactions in the Solid Phase.* **N. Semenoff** and **A. Schalnikoff.** (Zeits. f. Physik, 38. 9–10. pp. 738–744, 1926.)—Highly dispersive mixtures of cadmium and sulphur were obtained by condensation from two streams of vapour upon a surface cooled by liquid air, and it was found that for a critical temperature of the cooled surface ($-130°$ C. $> T_c > -180°$ C.) an explosive type of reaction took place between the cadmium and sulphur. Detailed diagrams of the apparatus are given. W. H. Ge.

507. *Experiments upon the Reported Transmutation of Mercury into Gold.* **M. W. Garrett.** (Roy. Soc., Proc. 112. pp. 391–406, Sept. 1, 1926.)—The results of Miethe and Stammreich [see Abstract 1509 (1925)] and of Nagaoka have not been confirmed. Details are given in the paper of the comprehensive experimental investigation carried out whereby 10^{-8} gm. of gold, if present, could not have escaped detection, and which should have yielded gold at least 10^4 times greater than the amount which could have been identified. The author concludes that Miethe and Stammreich's gold must have been derived from the electrodes and vessels. H. H. Ho.

508. *Dissociation of Heteropolar Molecules under Light.* **V. Kondratjew.** (Zeits. f. Physik, 39. 2–3. pp. 191–194, 1926.)—A salt molecule is broken up by absorption of light into an excited metal atom and an uncharged halogen atom. A. D.

509. *Formation of Protective Oxide Films on Copper and Brass by Exposure to Air at Various Temperatures.* **W. H. J. Vernon.** (Chem. Soc., J. pp. 2273–2282, Sept., 1926.)—Results are given of experiments on the formation of protective films on annealed electrolytic copper and 60 : 40 brass heated to various temperatures in an electric muffle for about an hour, the metal being afterwards cooled in a vacuum and re-weighed. For the low-temperature (up to 250°) oxidation of copper the results obtained are approximately in agreement with Pilling and Bedworth's equation, $K = AT^n$, where K is the rate constant (square of weight-increment per unit area per unit time), T is the absolute temperature and A and n are constants (J. Inst. Metals, 29. pp. 529–

582; Disc. and Corres., 583–591, 1923.) With Dunn's equation, $d \log W/dT = -Q/RT^2$ [Abstracts 2218, 2219 (1926)], however, the agreement appears perfect. Although it produces practically no visible effect on the metal, an hour's heating of copper at 75° C. is sufficient to inhibit entirely the development of interference colours on subsequent exposure to tarnishing conditions. A sudden break in behaviour between 55° and 75° suggests that a minimum thickness of the film is essential to afford protection, and this minimum thickness of film (10·5 Å) is nearly of the same order of magnitude as that usually accepted for the lattice dimensions of cuprous oxide. The gravimetric method does not give a satisfactory response to visible changes in these cases, the measurement of loss of reflectivity being preferable. Similar protection of copper is obtained by prolonged (a month) exposure of the metal to a pure atmosphere at the ordinary temperature. Although oxide films on brass (60 : 40) are not so efficacious as those on copper, evidence is cited to show that the protection extends to brass, the effects being confined mainly to the suppression of further colour changes. T. H. P.

510. *Studies on Catalytic Combustion. Part III. Influence of Steam on the Catalytic Combustion of Carbon Monoxide.* **W. A. Bone.** (Roy. Soc., Proc. 112. pp. 474–499, Oct. 1, 1926.)—Experiment shows that the progressive removal of moisture from a system in which carbon monoxide and oxygen are undergoing catalytic combination in contact with porous porcelain, copper oxide, nickel oxide, gold or silver at temperatures up to 500° C. may have three different consequences. The immediate result is to remove from the surface the film of water molecules which normally lags it to a greater or less extent, the effective area and the apparent catalysing power being thus increased; this result is most evident with a very porous surface like that of porcelain [see Abstracts 640, 1162 (1926)]. The real effect of extreme drying is to arrest the catalytic combustion altogether, and is most easily observed with a metal surface such as that of gold or silver, where the moisture film referred to above is apparently more attenuated and less adherent than with more porous surfaces. When the reactivity of the system has been reduced practically to zero by thorough drying, the re-introduction of a small amount of moisture immediately restarts the catalytic combustion and in course of time restores its normal intensity. These effects of drying and re-moistening may be demonstrated repeatedly on one and the same system. With porous porcelain, very prolonged drying apparently effects permanent disablement of the surface as a catalyst, presumably owing to structural change. T. H. P.

511. *Explosive Reactions in Gases. Parts I and II.* (Faraday Soc., Trans. 22. pp. 253–375, Oct., 1926.)—A general discussion on the subject comprising the following twelve papers, together with expressions of views by different contributors: "Explosive Reactions Considered Generally" (Introduction to Part I), by **W. E. Garner.** A review is given of the work which has been conducted on the factors operating in gaseous explosions, the temperatures of combustion and specific heat of gases, the speed of chemical reaction, ignition temperatures and the period of pre-flame, the propagation and uniform movement of flame, the limits of inflammability for different gases, activation through emission of radiation and of ions which precede flame or the explosion wave, the properties of the detonation wave, and chemical kinetics and catalysis in gaseous explosions. "The Ignition Point of Gases," by **H. B. Dixon, J. Harwood** and **W. F. Higgins**. Results are given of experiments made with a concentric tube method in which two separately heated gases consisting of hydrogen or methane and air or oxygen under different pressures are brought together so that they inflame as they mingle before reaching a solid surface. Determinations are made of the duration of the pre-flame period. Data are also given on measurements made by adiabatic compression, in which a falling weight is employed. "Radiation in Gaseous Explosions," by **W. T. David**. In exploding gaseous mixtures of hydrogen or coal-gas and air contained in a closed vessel, the radiation, after passing through a fluorite window, is measured by a bolometer and the change with time is compared with the rise of temperature as inferred from the gas pressure curves. The bulk of the emission is found to occur during the cooling period after the maximum temperature has been reached. By introducing infra-red radiations into mixtures of hydrogen, methane, or carbon monoxide with air before explosion it is found by measurements of the rise of pressure with time made with an optical indicator that the rate of combustion after ignition by an electric spark is increased. The phenomenon is limited to mixtures in which nitrogen is present. "Ionisation in Gas Explosions," by **W. E. Garner** and **S. W. Saunders**. From a consideration of the available data from different investigators it is concluded that the ionisation occurring in gaseous explosions is mainly thermal in character and plays no part in the ignition of gases by adiabatic compression, and that the hypothesis that the ionisation of gas in front of the explosion wave is the cause of the propagation of the detonation wave appears to have been disproved. "Ionisation and Gaseous Explosions," by **S. C. Lind**. A brief review is given of investigations that have been made to establish an electronic theory of flame propagation whereby a cycle is developed in which chemical action at high temperatures leads to the formation of gas ions and these in turn induce further chemical action. It is concluded that no definite evidence has been found for the theory, and the present trend of support is towards purely thermal propagation. "The 'Uniform Movement' during the Propagation of Flame," by **W. Payman** and **R. V. Wheeler**. Data are given on the rates of uniform movement of flame in mixtures of methane and oxygen in presence of nitrogen, argon and helium. The results agree with the values derived from the formula of Mallard and Le Chatelier. With inflammable gases generally the speed is also shown to be related to the rate of development of pressure. "The Explosion-Wave in Cyanogen Mixtures and the Specific Heats of Nitrogen," by **C. Campbell** and **H. B. Dixon**. The effect of dilution with successive additions of argon and nitrogen on the rate of the explosive wave in mixtures of cyanogen and oxygen is ascertained by means of the formula of Jonguet, a calculation is made of the mean molecular specific heats of nitrogen and carbon monoxide on the assumption that these are the primary products of the reaction. The values fall fairly evenly on a curve bending down towards the values obtained from the velocity of sound in nitrogen between 0° and 1000° C. "Ionisation in Hydrogen and Oxygen Explosions," by **W. E. Garner** and **S. W. Saunders**. Measurements are made of the electrical conductivity between two electrodes placed in exploding mixtures of hydrogen and oxygen with various admixtures. The addition of water has no effect, but excess of oxygen or of hydrogen and nitrogen decrease the conductivity. The addition of small quantities of benzene, carbon disulphide, carbon tetrachloride, ethyl iodide, ethyl bromide, and lead tetraethyl, which tend to prevent detonation in the internal combustion engine, are found to reduce the electrical conductivity materially, whereas the so-called knock inducers, such as ethylene dibromide and ethyl nitrate, increase the conductivity. "Explosive Reactions Considered in Reference to Internal Combustion Engines" (Introduction to Part II), by **D. Clerk.** An introductory survey is given of the temperature-volume relations in explosions in internal combustion engines. "Combustion in Gas Engines," by **W. T. David.** A discussion is given on the extent to which incomplete combustion of the charge is responsible for limiting the pressures developed in gas engines and the factors influencing the rate of combustion. "Explosions in Petrol Engines," by **H. T. Tizard.** A review is given of recent work bearing on the efficiency of petrol engines. "The Effect of Metallic Sols in Delaying Detonation in Internal Combustion Engines," by **C. J. Sims** and **E. W. J. Mardles.** [See Abstract 1544B (1926).] J. N. P.

512. *Velocity of Gas Reactions.* **J. A. Christiansen.** (Cambridge Phil. Soc., Proc. 23. pp. 438–449, Oct., 1926.)—Certain conclusions arrived at in a paper by G. N. Lewis and D. F. Smith [see Abstract 2180 (1925)] are critically discussed with special reference to particular points, amongst which it is argued that, contrary to a statement therein made, the heat of activation is always the heat required to bring an average molecule at a certain temperature to the average "state of activation" at the same temperature. A. B. C. L.

513. *Parallelism between the Effect of Neutral Salts on the Electrical Charge of Hydrated Manganese Oxides and the Concentration of Hydrogen Ions Liberated.* **B. Ghosh.** (Chem. Soc., J. pp. 2605–2614, Oct., 1926.) —The investigation of the oxides of manganese of variable composition here described was made with the object of deciding if the acid reaction developed by hydrated manganese dioxide in contact with neutral solutions of salts is explained the better by considerations of solubility or by the conception of an equilibrium between hydrogen ions and kations in the double layer and those in solution. The facts are found to be accounted for satisfactorily by Mukherjee's adsorption theory [Abstract 91 (1923)], the capacity of the different kations to liberate hydrogen ions being in the order Ba > Sr > Mg > K > Na > Li, which is the same as that obtained from electro-osmotic experiments and represents their capacity to neutralise the negative charge of the surface. The bivalent kations reverse the sign of the charge of the surface, showing that the primarily adsorbed ions are univalent. The electrical adsorption of one bivalent kation will therefore liberate one hydrogen ion. In addition, hydrogen ions are probably replaced by kations penetrating into the mobile sheet of the double layer on account of their osmotic pressure. T. H. P.

514. *Influence of Electrolytes in Electro-Endosmosis.* **H. C. Hepburn.** (Phys. Soc., Proc. 38. pp. 363–376; Disc., 377, Aug., 1926.)—This paper gives the results of electro-endosmotic determinations with certain aqueous solutions of electrolytes in glass diaphragms, and values are obtained for the interfacial potential of the Helmholtz electrical double layer. The dependence of the conductivity on the electro-endosmotic flow has been investigated by measurements of the current flowing through the diaphragm during each determination, and the data used to trace the variations in the thickness and the charge of the electrical double layer by the application of a formula derived by Smoluchowski. AUTHOR.

515. *Ionic Activity.* **E. Güntelberg.** (Zeits. phys. Chem. 123. pp. 199–247, Sept. 15, 1926.)—Electrometric measurements are made by the hydrogen electrode, in conjunction with a silver/silver chloride electrode, of the activity coefficients of hydrochloric acid solutions of concentrations from 0·01 N to 1 N. Sources of error due to the method of preparation and use of the silver electrodes are discussed. The activity coefficient has a minimum value at about 0·35 N. The relation between concentration and activity is found to agree to within 0·05 millivolt with the equation of Hückel :—

$$\log f = -0\cdot 500\frac{\sqrt{c}}{1 + 1\cdot 4\sqrt{c}} + 0\cdot 136c - \log(1 + 0\cdot 036\,\text{m.}),$$

where f is the mean activity coefficient of H and Cl, m is the concentration of hydrochloric acid in gm.-mols. per 1000 gm. of water and c the concentration in gm.-mols. per litre. Measurements are further made of the activity coefficients of HCl in mixtures of the chlorides of Li, Na, K and Cs, in which the total chloride concentration is 0·1 gm. in 1000 gm. of water. It is shown that a linear relation exists to within 0·02 millivolts between the values of $\log f_{\text{HCl}}$ and the ratio $\frac{m(\text{salt})}{m(\text{salt}) + m(\text{HCl})}$, where m is the molecular concentration. Solubility measurements are made of the compound $\text{Co[NO}_2\text{ . SCN . (NH}_3)_4]\text{Cl}$ in the different chlorides under similar conditions and a similar linear relation is found between the osmotic coefficients and the above ratio. The variations of f_{HCl} in the different media are in agreement with the thermodynamical deductions of Brönsted and depart from the relation assumed by MacInnes, Harned and Lewis, according to which the activities of particular ions are independent of the presence of other ions. With mixtures containing a common ion, but not with heterionic mixtures, the linear variation relation is in agreement with Brönsted's theory of specific interaction when treated from the standpoint of the theory of Debye-Hückel of complete dissociation. J. N. P.

516. *Milner and Debye Theories of Strong Electrolytes.* **G. Scatchard.** (Phil. Mag. 2. pp. 577–586, Sept., 1926.)—Commenting on comparisons of the two theories made, with conclusions unfavourable to the Debye theory, by Pike and Nonhebel [see Abstract 185 (1926)], and by Nonhebel and Hartley [see Abstract 204 (1926)], the author critically discusses the two theories, with special reference to the e.m.f. of HCl in methyl alcoholic solution at 25° C., showing a better agreement between the values calculated from the Debye theory and the experimental data than those obtained from the Milner theory. The discrepancies arising from the latter theory are attributed mainly to inaccuracy of extrapolation. A. B. C. L.

517. *Milner and Debye Theories of Strong Electrolytes.* **G. Nonhebel** and **H. Hartley.** (Phil. Mag. 2. pp. 586–587, Sept., 1926.)—The authors reply to the criticism of G. Scatchard [see preceding Abstract], quoting a letter subsequently received from Milner, who admits that Debye's observation that the average potential at a point of all the ions in a sphere containing a positive ion at the centre must satisfy Poisson's equation, enables a more accurate calculation of the effects of interionic force to be made. A. B. C. L.

518. *Beryllium.* **A. C. Vivian.** (Faraday Soc., Trans. 22. pp. 211–225, Sept., 1926.)—Beryllium is prepared in the form of compact cylindrical rods by the electrolysis of a fused mixture of the double fluoride BeF_2, NaF with the addition of pure barium fluoride sufficient to raise the barium content to between 10 and 15 %. The electrolyte is contained in a graphite pot and heated by a surrounding coil of nichrome wire and by the insertion of graphite electrodes between which an alternating current is passed. Corrosion of the graphite is retarded by impregnating with sodium chloride. The kathode consists of a water-cooled holder which is arranged to rotate axially and is suspended above the surface of the bath so as just to make contact between the bath and the metal deposited on its tip. Electrolysis proceeds continuously at a bath temperature of 1300° C., the furnace being fed with fluorides at regular intervals. The metal obtained is free from impurities except small traces of iron, carbon, aluminium and magnesium, melts at 1280° C., has a specific gravity of 1·84, a Brinell hardness of about 140, and is well resistant against atmospheric corrosion. J. N. P.

519. *The Anodic Behaviour of Ferromanganese.* **A. N. Campbell.** (Faraday Soc., Trans. 22. pp. 226–232, Oct., 1926.)—The anodic behaviour of ferromanganese is investigated in various electrolytes and under various conditions. Both constituents dissolve and there is never complete passivity, but very large passivity in certain electrolytes. In hot potassium hydroxide there is no formation of manganate, in contradistinction to the behaviour of pure manganese. The standard methods of reducing passivity are shown to be valid here. The slimes are in most cases heavy and, under a gas discharge, the anode disrupts completely. Hence ferromanganese is useless as an insoluble anode. The stability of ferromanganese under ordinary conditions is not a very deep-seated phenomenon, since the passivity can be so readily destroyed, notably by rise of temperature. J. N. P.

520. *Periodic Phenomena at Different Anodes.* **E. S. Hedges.** (Chem. Soc., J. pp. 2580–2594, Oct., 1926.)—Periodic changes in potential and in current strength are observed between certain current densities in the electrolysis of the following solutions, a platinum kathode being used throughout: zinc anode with sodium hydroxide, sulphuric acid; cadmium anode with sulphuric acid, potassium cyanide; mercury anode with potassium cyanide, sodium hydro-sulphide, nitric acid; magnesium anode with sulphuric acid; tin anode with sulphuric acid, nitric acid; lead anode with sodium hydroxide. In all cases the metal dissolves at low current densities, while at higher current densities a film forms over the metal, the p.d. rises and oxygen is evolved. Periodic phenomena are realised by arranging the current density between two well-defined and often very narrow limits when the electrode oscillates continuously between the two states. The limits depend on the temperature, concentrations and nature of the solution. [See Abstract 2494 (1926).] J. N. P.